THE MUNICIPAL AND SANITARY

ENGINEER'S HANDBOOK.

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PREFACE TO THE FIRST EDITION.

IN carrying out the many duties devolving upon a Borough Surveyor, it has so often been my wish to turn to a practical book of reference upon the many subjects connected with these duties, that I have written the following pages; and I trust that they will form a useful Handbook.

H. PERCY BOULNOIS.

PORTSMOUTH,
May, 1883.

PREFACE TO THE SECOND EDITION.

THE growth of Sanitary knowledge and legislation has made a second edition of this book necessary. I have therefore endeavoured to so define and explain this knowledge and legislation as to bring this edition up to date.

H. PERCY BOULNOIS.

LIVERPOOL,
October, 1891.

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MUNICIPAL

AND

SANITARY ENGINEERS' HANDBOOK.

CHAPTER I.

THE TOWN SURVEYOR.

THE office of town surveyor was first legalised by the Towns Improvement Clauses Act 1847 under the following section:

"The Commissioners shall appoint, subject to the prescribed approval, or where no approval is prescribed, subject to approval by one of Her Majesty's principal Secretaries of State, a person duly qualified to act as a local surveyor of the paving, drainage, and other works authorized under the provisions of this and the special Act . . . . and the Commissioners with the like approval may remove any such surveyor" (10 & 11 Vic. c. 54, s. 7).

For some considerable period prior to this date however similar appointments had been made in several of the more important English towns, notably in the case of Liverpool where in the year 1842 surveyors had been appointed under the Liverpool Building Act.* In the year 1848 the legal

* The section of the Act is as follows:—"And be it enacted that it shall be "lawful for the Council within six months after the commencement of this Act, "and from time to time as vacancies shall happen, to appoint a fit person, or so "many fit persons (not being surveyors of the estates of the mayor, aldermen,

office of surveyor was confirmed by the Public Health Act 1848 (11 & 12 Vic. c. 63, s. 37), and it is now law under the Public Health Act 1875 (38 & 39 Vic. c. 55): that comprehensive statute, under which all Sanitary Acts are now included, and which Act with the Amendments thereto (notably the Public Health Acts Amendment Act 1890, 53 & 54 Vic. ch. 59) will be frequently alluded to in the course of this book.

The clause which specially refers to the appointment of the surveyor is as follows:—

"Every urban authority shall from time to time appoint fit and proper persons to be medical officer of health, surveyor, inspector of nuisances, clerk, and treasurer: Provided that if any such authority is empowered by any other Act in force within their district to appoint any such officer, this enactment shall be deemed to be satisfied by the employment under this Act of the officer so appointed, with such additional remuneration as they think fit, and no second appointment shall be made under this Act. Every urban authority shall also appoint or employ such assistants, collectors, and other officers and servants as may be necessary and proper for the efficient execution of this Act, and may make regulations with respect to the duties and

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"and burgesses of Liverpool), as the Council shall think fit, to be surveyors of "buildings within the borough, and for other the purposes of this Act, and to see "that the several provisions of this Act, and also the several provisions of an "Act passed in the third and fourth years of the reign of her present Majesty, "intituled 'An Act to provide for the regulation of Chimney-Sweepers and "Chimneys,' and the rules and regulations for the time being of the health "committee are well and truly observed therein, and each of the said surveyors "shall have in his special charge such district of the borough as the council shall "in that behalf appoint; and each of the said surveyors shall hold his office "during the pleasure of the council, and may, if the council shall so think fit, "but not otherwise, have an assistant or assistants under him (such assistants "being in all cases appointed by, and holding their situations during the pleasure "of, the council), and the council shall have authority to fix the districts in which "the said surveyors are to act within the borough, and do all things relating in "anywise to the appointment and direction of such surveyors and assistant-"surveyors" (4 & 5 Vic. c. 44, s. 29).

conduct of the officers and servants so appointed or employed . . . " (38 & 39 Vic. c. 55, s. 189), and these officers (except the medical officer of health and the inspector of nuisances, when any portion of their salary is paid out of moneys voted by Parliament to the powers of the Local Government Board), may be removed by the urban authority at their pleasure, which was not the case when the appointment was first made in 1847.

Here it is necessary to state that for sanitary purposes England and Wales are divided into four divisions—viz. urban sanitary districts, rural sanitary districts, the former of these divisions being further subdivided into boroughs, where the urban sanitary authority is the mayor, aldermen, and burgesses acting by the council, and districts which are under the authority of improvement commissioners or local boards; the rural sanitary districts are the areas of unions not included in urban districts, and they are under the authority of the guardians of the union; and also into County Councils which were established in 1889 in every administrative County and also 61 large Boroughs were constituted County Boroughs (51 & 52 Vic. c. 41). *

It is my intention to deal more particularly with the duties of a surveyor acting under an urban authority, but the following section of the Public Health Act 1875 relates apparently to the appointment of a surveyor to a rural authority, † although no mention is made in this or any other clause of the Act directly of such an officer by name, except that amongst the definitions of the Public Health Act the following appears :—

"'Surveyor' includes any person appointed by a rural

* The following authorities are responsible for the repair and maintenance of roads and streets throughout the country :—County Councils (formerly County Justices in Quarter Sessions), County Boroughs, Boroughs, Local Boards, Urban and Rural, single parishes without local boards, grouped parishes formed into Highway Boards, Road Trustees (almost extinct), Imperial Government.

† Surveyors of highways are appointed under sec. 25, 41 & 42 Vic. c. 77.

authority to perform any of the duties of surveyor under this Act" (38 & 39 Vic. c. 55, s. 4).

The clause I have above referred to is as follows:—

"Every rural authority shall from time to time appoint fit and proper persons to be medical officer or officers of health and inspector or inspectors of nuisances; they shall also appoint such assistants and other officers and servants as may be necessary and proper for the efficient execution of this Act . . . " (38 & 39 Vic. c. 55, s. 190).

The following clauses apply to officers of rural as well as urban authorities:—

"The same person may be both surveyor and inspector of nuisances . . . " (38 & 39 Vic. c. 55, s. 192).

"Officers or servants appointed or employed under this Act by the local authority shall not in any wise be concerned or interested in any bargain or contract made with such authority for any of the purposes of this Act . . . " (38 & 39 Vic. c. 55, s. 193).

"Before any officer or servant of a local authority enters on any office or employment under this Act by reason whereof he will or may be entrusted with the custody or control of money, the local authority by whom he is appointed shall take from him sufficient security for the faithful execution of such office or employment, and for duly accounting for all moneys which may be entrusted to him by reason thereof" (38 and 39 Vic. c. 55, s. 194).

In addition to these clauses, there are several regulating the receipt of money by officers, but these should not affect the town surveyor. Although in many places he has the onerous duty of paying workmen, certifying tradesmen's accounts, and other financial transactions, he ought under no circumstances to have anything to do with the receipt of money. Unfortunately, in some of the smaller towns the surveyor is also employed as rate collector; but as this is evidently a very improper proceeding, I shall not further allude to it in any manner.

It will be observed that in the foregoing clauses of the Public Health Act the word "surveyor" is always used, and thus this is the legal title of those holding such appointments, with the single exception of the City of Liverpool, where the Council are legally empowered to appoint, subject "to "approval of one of Her Majesty's principal Secretaries of "State" a person duly qualified as a Civil Engineer to act as Local Surveyor of the drainage and other works authorized under the provisions of this Act.* It is obvious that, although the title of Surveyor may have well suited the office up to the year 1847, when it was made the legal title, the prodigious growth of municipal work during the last 43 years has made it necessary that some change should be made, and the title

* As the clauses of the acts bearing upon this subject are particularly interesting, I give them in full. The Liverpool Sanitary Act, 1846: "enacts, "that the said council shall, and they are hereby authorized and required "to appoint, subject to approval by one of Her Majesty's principal secre- "taries of state, and with such salary as they shall think fit, to be paid out "of the moneys to be raised by virtue of this Act a person duly qualified as a civil "engineer, to act as a local surveyor of the drainage and other works authorized "under the provisions of this Act; and if any such surveyor shall die, resign, or "be removed, the said council shall with the like approval, appoint another "person so duly qualified in the room of the surveyor so dying, resigning, or "being removed" (9 & 10 Vic. c. 127, s. 22).

The Liverpool Sanitary Amendment Act, 1854, sec. 4, provides: "That the "person appointed by the council to act as local surveyor of the drainage and "other works authorized under the provisions of 'The Act ninth and tenth of "Victoria, chapter one hundred and twenty-seven, Liverpool Sanitary Act, 1846,' "shall be called and known as the 'Borough Engineer' (17 Vic. c. 15, sec. 4).

The Liverpool Corporation Act, 1880, sec. 10, provides: "All the provisions "of the Liverpool Corporation Acts and Orders 1786 to 1880, and of any other "public or private Act of Parliament, order, deed or other document relating to "the Borough of Liverpool or to the mayor, aldermen, and burgesses thereof, or "to any officer of the said borough, shall apply to the City of Liverpool and to "the mayor, aldermen, and citizens thereof, and to the officers thereof in all "respects as if those Acts, orders, deeds or documents had expressly mentioned "or referred to the City of Liverpool, or the mayor, aldermen, and citizens, or "the officers thereof, and the officers formerly known as the borough treasurer "and borough engineer shall henceforth be styled respectively the city treasurer "and the city engineer, and the fund and rate formerly known as the borough "fund and borough rate shall henceforth be styled respectively the city fund and "the city rate, and all the provisions of any such Act, order, deed, or other "document as aforesaid shall be read and have effect accordingly."

altered to that of "engineer," or some other similar suitable name. At the present time several different meanings and occupations are attached to the word "surveyor," as the following list will show:—"land surveyor," "district surveyor," "county surveyor," "road surveyor," "surveyor of taxes," "surveyor of customs," "quantity surveyor," "fire insurance surveyor," "Lloyd's surveyor," and a still more curious instance where an urban authority is itself dubbed "surveyor of highways" by the 144th section of the Public Health Act, 1875; and the title of town surveyor as now applied cannot but lead to confusion and to perfectly erroneous impressions as to his work and duties.

Sir Henry Ackland, in a paper read before the Association of Municipal and Sanitary Engineers and Surveyors, at a district meeting held at Oxford, makes the following remarks on this point:—"In the Public Health Act, 1875 (the summary of all health enactments) the name of 'engineer' does not once occur in the 343 clauses. He is still the old 'surveyor' we all remember, the plodding, energetic man of highways and bye-ways . . . but then the surveyor of the present day may be called on to advise on anything, from the form and cost of an earthen syphon trap to the calculation of work to be done by engines which are to supply half a million of persons with water; to be responsible for the construction of sanitary mechanisms, from a housemaid's sink to an intermittent downward filtration farm."

There can be but little doubt that it is absolutely necessary for the town surveyor of the present day to be a competent civil engineer of great knowledge and varied experience, for he may at any moment be called upon to advise his corporation upon any of the following subjects, or to act in any one of the following capacities, in addition to the multifarious ordinary duties legally devolving upon him as Surveyor under the Sanitary Acts:—

(1.) As engineer for sewerage and sewage works.

(2.) As engineer for water and gas works.

(3.) As engineer for canals, docks, harbour improvements, and river navigation, or for the protection of coasts against the encroachments of the sea, and the prevention of floods by rivers.

(4.) As engineer for the construction and maintenance of roads and bridges.

(5.) As engineer for the construction and maintenance of lines of tramways.

(6.) As engineer to advise on schemes for Electric Lighting.

(7.) As architect for the construction of lunatic asylums, municipal offices, hospitals, abattoirs, mortuaries, baths and wash-houses, cemetery chapels, stables, police stations, and other similar works.

(8.) As landscape gardener for the laying out of public recreation grounds, parks, and cemeteries.

(9.) As quantity surveyor to make estimates of all works, and sometimes to furnish bills of quantities to intending contractors.*

(10.) As surveyor and valuer to advise his employers on the values, &c., of corporate or other property.

(11.) As land surveyor to make surveys of any size that may be required.

(12.) As accountant to examine and rectify the workmen's wages sheets, and all tradesmen's accounts for work performed or goods supplied.

The foregoing list is no exaggeration of the onerous duties of the town surveyor, and it seems to be a grievous mistake that this officer, whose importance in all practical sanitary

* In the first edition of this book the author's meaning with regard to this duty of a surveyor was somewhat misunderstood. The author is of opinion that bills of quantities should not be furnished by the surveyor unless he is paid the usual quantity surveyor's commission, as the furnishing of quantities throws a considerable pecuniary responsibility upon the surveyor, for which he ought in common justice to be paid.

work cannot be over-stated (as without him no useful municipal work could go on), has been left unprotected by the Public Health Act of 1875.

In that Act both the medical officer of health and the inspector of nuisances have received Government protection, whereas the surveyor, the very officer of all others who necessarily is more likely to come into collision and to be unpopular with his employers in the faithful discharge of his duties, has been afforded no protection whatever, but has been left to the tender mercies of an annually changing body of municipal governors, "to be removable at their pleasure" (38 & 39 Vic. c. 55, s. 189).

On this highly important point I cannot do better than quote several passages from Mr. Lewis Angell's interesting address to the Association of Municipal and Sanitary Engineers and Surveyors on the occasion of their inauguration in the year 1873:*

"The 'town surveyor,' according to his opportunities, has done the country good service, but, surrounded as we have been with obstructions and difficulties, cramped and restricted by popular prejudices and private interests, subject to clamour and attack, without protection and without appeal, it is indeed surprising that we have accomplished so much. Had such officers been from the first judiciously selected, adequately remunerated, properly supported, and duly protected, our influence upon sanitary progress would have been more conspicuous and our office better appreciated.

"As engineers we do not pretend to a knowledge of medical science, but it is equally within the knowledge of the average sanitary engineer as of a medical officer of health that pure air, pure water, properly constructed houses, and an unpolluted soil are the cardinal conditions of health. These are mere sanitary axioms. The means by which such con-

* *Vide* 'Minutes of Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. i. p. 18.

ditions are attained are drainage, ventilation, water-supply, and other matters entirely within the functions of the engineer. It is the function of the sanitary engineer to prevent that which the medical officer of health is called upon to detect. . . .

"In many cases the unprotected surveyor may be required to report to a protected medical officer the negligence of his own employers. No local surveyor or engineer can be expected to give cordial and active assistance in compulsory sanitary work when he is conscious that his action would be opposed to the views or the interests of his employers, the public upon whom he is dependent. The existence of such a distinction between the medical officer and surveyor under the same board will produce a want of harmony in interest, and must lead to a divergence of action between the two departments. . . ."

And, speaking of the multifarious duties of the town surveyor, Mr. Angell says: "Any one section of his duties would, under commercial circumstances, command fair pay according to its importance; but where cumulative duties are included in the same office, they demand constant attention, special knowledge, professional experience, and administrative ability; to which is added the anxiety which the responsibilities of public office always involve. Such a position in a commercial concern would receive high remuneration in proportion to the extent of the undertaking, but unfortunately, our work does not pay a dividend: it is all expenditure from which the town derives no return excepting in health and comfort, matters which are neither fairly assessed, nor duly appreciated; consequently, the municipal engineer is paid less for his professional knowledge than the contractor's agent whose work he directs."

Speaking further on the subject of Government protection, Mr. Angell says: "Surveyors appointed under the Towns Improvement Clauses Act were protected during the exist-

contribution, and to allow four per cent. compound interest on the amounts paid in to the fund.

(*c.*) Superannuation to be paid on a fixed scale, say one-sixtieth of average salary for the last ten years multiplied by number of years of service, on an officer attaining the age of sixty, or becoming permanently incapacitated from work. Or he may take the amount standing to his credit with four per cent. compound interest.

(*d.*) In case of death before superannuation his personal representatives to draw the amount standing to his credit with four per cent. compound interest.

(*e.*) In case of death after superannuation but before he can have drawn an equivalent sum to the amount standing to his credit, the officer's personal representatives may draw the amount still standing to his credit.

(*f.*) In case of voluntary resignation the officer to withdraw the whole amount standing to his credit, but without interest.

(*g.*) In case of dismissal other than for fraud the officer to withdraw his own money contributed, but not the Corporation contribution or any interest.

(*h.*) In case of dismissal for fraud, the whole to be forfeited.

(*i.*) In case of long illness advances to be made of an amount not exceeding one-fourth of sum standing to officers credit, no second advance to be made until the first advance has been repaid.

(*j.*) The management of the fund to be in the hands of a committee of the Corporation with certain officials added to them.

Such a scheme if carried out must result in a better feeling between the officials and their employers, and the probability of the services of the best officials being retained, as they would have a sum of money at stake with the Corporation which was increasing every year. It would also add to their energy and attention, as they would feel relieved of anxiety

and care for the future. Additional security is also ensured in case of possible fraud by an official.

The time will no doubt come when the necessity for some change in the position of the town surveyor will be apparent, and adequate protectiön will be afforded him; in the meantime let him strive, by attention to work, and by daily advancement in scientific knowledge, and in courtesy to those with whom he is associated, to make the position and power of the town surveyor felt and honoured as it should be throughout the kingdom.

CHAPTER II.

THE APPOINTMENT OF SURVEYOR.

WHENEVER a vacancy occurs in the office of a surveyor to a town, or upon a sanitary authority determining to make such an appointment, the question is usually relegated to a committee or sub-committee to report upon the subject, to fix the amount of salary proposed to be given, and frame the duties of the office.

The following report emanated from an important English borough, and is given in full as a specimen, and as a guide on which a report could be framed; altered, of course, to such requirements as may be locally necessary :—

Report of the Special Sub-Committee as to the Surveyor.

(1.) Your sub-committee report that they have, in compliance with the resolution of the day of , carefully considered the steps to be taken with reference to the vacancy caused by Mr. ———'s resignation, and they have come to the unanimous conclusion that it is desirable that the office of surveyor should be continued.

(2.) Your sub-committee have also considered the duties which were assigned to the office of Mr.———'s appointment, and they beg now to submit them, revised in accordance with the present circumstances of the department, and with the recommendations contained in this report.

(3.) Your sub-committee further recommend that the salary of the surveyor be fixed at £ . . per annum, and that advertisements be issued for candidates.

*Duties of the Surveyor.**

(1.) To have charge of the repairs of all highways, and to perform all duties devolving on the council as surveyors of highways.

(2.) To report from time to time to the committee superintending the same, the state of the several highways and lines of tramway, and as to the materials wanted or works necessary.

(3.) To prepare all plans, specifications, or instructions necessary in relation thereto, and as to the materials to be used therein, and to see that all works are completed according to contracts entered into.

(4.) To engage and dismiss under sanction of the committee all workmen employed at daily and weekly wages.

(5.) To certify all accounts for work done, materials supplied, and wages due.

(6.) To have charge of all materials and implements.

(7.) To purchase or contract for, or hire all horses, carts, tumbrils, stones, flags, gravel, draining pipes, and proper implements and materials, and all other matters and things, at such prices and in such manner as the committee shall judge reasonable and expedient, and to sell or otherwise dispose of the same as he may be directed.

(8.) To have the entire charge and superintendence of the breaking up and repairing of all streets, for the purpose of laying or replacing gas and water pipes.

(9.) To inspect and report, in conjunction with the medical officer of health, upon slaughter-houses preliminary to licences being granted, and to make the plans and superintend the construction of any slaughter-houses which the council may hereafter erect.

* Under the Public Health Act, 1848, the duties of officers were regulated by bye-laws, but now they are only the subject of regulations which by sec. 188 Public Health Act, 1875, do not require confirmation by the Local Government Board ('The Law of Public Health' (Glen), 10th edition, page 365).

(10.) To take all levels and surveys which may be necessary for the purpose of deciding on the best mode of draining the several districts, or any part thereof, or for the purpose of fixing the levels and inclinations of any streets or roads, or in anywise relating thereto.

(11.) To carry out the scheme now in course of construction for the interception of the sewage of the borough, and any future scheme, for its precipitation, filtration, deodorization, or any other process which the council may adopt, either within or without the borough.

(12.) To superintend the construction and completion of all tramway lines and sidings which may be required.

(13.) To prepare, from time to time, schemes for the drainage of the several districts or any part thereof.

(14.) To prepare all such plans, sections, and specifications as may be necessary for the due execution of any flagging, paving, sewering, or other works required to be done, or for entering into any contracts in relation thereto, and to see that all works are executed in accordance therewith.

(15.) To measure up and duly certify the execution of all works, and apportion the cost to the parties chargeable therewith.

(16.) To see that all house drains, which may from time to time be carried into any public sewer, are made and connected in accordance with the regulations.

(17.) To give to the several contractors performing any works, orders for the same in writing only, keeping duplicates thereof, duly entered in a book to be kept by him for that purpose.

(18.) To prepare all plans, drawings, and estimates required, and to superintend the execution of all improvements.

(19.) To see that no encroachments be made on any high-
the (3.)r public place.

To advise on, and execute, all engineering works,
salary of

all such plans, specifications, and estimates of,
that advertis

and take out quantities for, such sewers, buildings, bridges, and works as may be required, and to superintend the erection and execution thereof.*

(21.) To have in his charge, and be responsible for, the proper management of all buildings and properties belonging to the corporation, or for the repair and maintenance of which the corporation is liable, except otherwise directed by the council.

(22.) To examine and report upon all plans and elevations of buildings proposed to be erected or altered upon land sold or leased by the corporation.

(23.) To inspect and report on plans of new streets to be laid out, of houses to be built, and of buildings to be erected or altered.

(24.) To see that all streets are properly named, and that the name plates are kept in good order.

(25.) To act as building surveyor in all matters relating to the execution of the Sanitary and Local Acts, and to examine and certify new houses as fit for habitation.

(26.) To examine all buildings in a condition dangerous to the public, to report thereon, and to take such steps as may be necessary to prevent accidents arising therefrom.

(27.) To prepare all plans and sections for deposit, pursuant to Standing Orders, with respect to all street improvements, tramways, gasworks, waterworks, or other works, unless otherwise ordered by the council, and to prepare all other surveys, plans, and sections required.

(28.) To attend the meetings of the several committees when required.

(29.) To prepare all returns relating to his office that may be required by the Government.

(30.) To attend in London or elsewhere when required, without extra charge, excepting only his travelling and hotel expenses.

* *Vide* remarks in footnote at bottom of page 7.

(31.) To keep accurate permanent records and plans relating to all properties purchased, leased, or sold, or in possession.

(32.) To devote the whole of his time to the duties of his office, and not to be engaged in any other office, business, or employment whatever.

(33.) To report from time to time all and every matter connected with any branch of his office which, in his opinion, may require the attention of any committee, and take their instructions thereon.

In addition to the very binding terms contained in clause 32 of this specimen report, some of the recent advertisements for the appointment of a surveyor have contained the following paragraph:

"He will be required to devote his whole time and "attention to the duties of his office, and will not be allowed to "take any private practice or hold any other appointment or "engage in any other business or employment whatever, and "any fees received by him either as a witness or in any other "capacity will have to be paid to the council."

It is evident that the restrictions placed on an officer by the latter part of this paragraph make it professionally impossible for him, without losing his self-respect, to act in any consultation, arbitration, or as a skilled witness, or in any other similar capacity where his services might be desired and be of considerable value, but where they are thus proposed to be "farmed out" by his employers.

It is questionable whether such restrictions are not really detrimental to the interests of the community he serves, for if an engineer has no opportunity of extending his professional knowledge and scientific experience outside the district in which he is engaged, it is more than probable that his views will become narrow and restricted, and consequently of less value to his employers.

Although it would no doubt be impolitic, and possibly unjust to other members of the profession, to allow a town surveyor an unlimited private practice, it cannot be doubted that under certain restrictions if he is allowed to increase the scope of his knowledge, gain experience in engineering skill, and raise his professional position, instead of being detrimental to the public service, it must be to the benefit of the ratepayers and to the credit of the corporation he serves.

Unlike the medical officer of health, who by Act of Parliament is required to hold a diploma of competency,* it is open to anyone to apply for and obtain the appointment of a town surveyor. This is no doubt unfortunate, as some test of merit is desirable, and of late years the necessity of some examination as to competency has been much discussed.

In order to meet this requirement, the Sanitary Institute instituted examinations in the year 1880, and grant certificates of competency for both town surveyors and inspectors of nuisances. The following particulars of these examinations, and the reasons given for their necessity, may be of interest, and are given in full.†

Examination of Local Surveyors and Inspectors of Nuisances.

"The great and increasing importance of the duties de-
"volving upon local surveyors and inspectors of nuisances in
"connection with the various statutes relating to Public
"Health and the Sale of Food and Drugs Act, has led the
"council of the Institute to establish voluntary examinations
"for local surveyors and inspectors of nuisances, and for
"persons desirous of becoming such, or of obtaining the certi-
"ficate of the Institute.

* "A person shall not be appointed Medical Officer of Health under this Act unless he is a legally qualified medical practitioner" (38 & 39 Vic. c. 55, sec. 191).

† *Vide* 'Calendar of the Sanitary Institution of Great Britain for the year 1880.'

"Each examination occupies a portion of two days. On "the first day the examination of surveyors is continued for "four hours, viz. from 2 to 4 and 6 to 8 P.M., and consists of "written papers only. Inspectors of nuisances have two "hours' written examination on the first day, viz. from 4 to 6 "P.M. On the second day the examination for both classes "commences at 11 A.M., and is *vivâ voce*, with one or more "questions to be answered in writing if deemed necessary. A "certificate of competence signed by the examiners is granted "to succcessful candidates.

"As rural sanitary authorities are able under the Public "Health Act 1875 to obtain almost all the powers of urban "sanitary authorities, it is not considered advisable to make "any distinction in the examination of the two classes of "surveyors.

"As one person may, under the Public Health Act 1875, "be both local surveyor and inspector of nuisances, candidates "wishing to obtain the double qualification may enter for "both examinations on the same occasion.

"Candidates are required to furnish to the council of the "Institute satisfactory testimonials as to personal character, "and to give two weeks' notice to the secretary previous "to presenting themselves for examination, stating whether "they wish to be examined as surveyors or inspectors of "nuisances, or as both.

"The fee for the examination must be paid to the secretary, "by post-office order or otherwise, at least six days before "the day of examination. On receipt of the fee a ticket will "be forwarded admitting to the examination.

"The fees payable for the examination are as follow :—

For Surveyors	£5 5 0
For Inspectors of Nuisances	2 2 0

"Unsuccessful candidates are allowed to present them- "selves a second time for one fee."

Syllabus of Subjects for Examination for Local Surveyors.

Laws and Bye-Laws.—A thorough knowledge of the Acts affecting sanitary authorities, so far as they relate to the duties of local surveyors; also of the model bye-laws issued by the Local Government Board.

Sewerage and Drainage.—The sanitary principles which should be observed in the preparation of schemes for, and the construction of sewerage works; the ventilating and flushing of sewers and drains; the internal drainage and other sanitary arrangements of houses, privies, water-closets, dry-closets, and the removal of refuse; the sanitary details of builders' and plumbers' work.

Water Supply of Towns and Houses.—The sanitary principles which should be observed in the preparation of schemes for, and the construction of, water-works; the various ways in which water is likely to become polluted and the best means of ensuring its purity.

Regulations of Cellar Dwellings and Lodging Houses.—General principles of ventilation; the amount of air and space necessary for men and animals; the means of supplying air and of ensuring its purity.

Highways and Streets.—The sanitary principles which should be observed in the construction and cleansing of streets and roads.

EXAMINATION PAPERS, NOVEMBER 6, 1879.

Questions for Surveyors, November 6, 1879, 2 *to* 4 *o'clock.*

1. Define street; state the law applicable to every description of street in an urban sanitary authority district, and the rights and obligations and duties of sanitary authorities, owners and occupiers therein.

2. What are the relative advantages of circular and egg-shaped sewers; in what case are they respectively preferred?

3. Give a specification of a water-tight sewer. Describe and give a sketch of the form of man-hole which you consider best adapted for ordinary town sewers, and state the rule which you adopt for determining the amount of ventilation to be afforded in a main street sewer.

4. In what way does the size and shape of the sewer affect the velocity of sewage flowing through it? If a nine-inch pipe sewer, laid at an inclination of 1 in 200, gives a velocity of 3 feet per second, what velocity will it give when laid at an inclination of 1 in 800, the pipe running full in each case? Will this velocity suffice to keep it clear from deposits? Describe the various modes which may be resorted to for flushing sewers.

5. Give a description of the process termed intermittent downward filtration. State what area of land you would require, with a gravelly soil, for applying this method of purifying sewage to a town with a population of 1000 inhabitants, and state the arrangements you would adopt for dealing with the rain-water falling on the roofs, yards, and streets.

November 6, 1879, 6 to 8 o'clock.

1. In reporting upon the source of water-supply for a town, what are the points to which you would direct your attention?

2. Give a sketch of a D trap, an S trap, a P trap, and a pan water-closet (plan of a dwelling-house annexed).

3. Criticise the arrangements of this residence as to position of rooms, walls, doors, fire-places, windows, &c., from a sanitary point of view.

4. Describe the drainage arrangements shown on the plan. Say whether they are satisfactory; if not, in what way are they faulty?

5. Sketch on the plan any other system of drains which you would think preferable.

6. Describe in detail the arrangements necessary for the water-supply of the residence, a bath being fixed in the room over the serving room, a W.C. on the first floor over that on the ground floor, and a housemaid's sink near.

It was always felt that it was open to question whether the Sanitary Institute was the proper authority to hold these examinations or not; but there is no doubt that some such examination was necessary, and if instituted and properly conducted would be welcomed by nearly all town surveyors in order to more firmly secure their positions; and the Sanitary Institute is entitled to every credit for having taken the initiative step in the matter.

Under these circumstances the Association of Municipal and Sanitary Engineers and Surveyors in the year 1886 undertook the holding of "Voluntary Pass Examinations for "candidates for Surveyorships under Municipal Corporations "and the Local Government Acts." The following are the particulars of these examinations which are held bi-annually, a comparison between the questions asked at these examinations and at those of the Sanitary Institute cannot fail to be of interest.

ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

VOLUNTARY EXAMINATIONS.

SYLLABUS.

THE ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS have undertaken the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

There will be two Examinations in each year, advertised in the "BUILDER" six months beforehand.

The Examination will be by written papers, and *viva voce* upon the four following subjects:—

1st. Engineering as applied to Municipal work.
2nd. Building Construction and Materials.
3rd. Sanitary Science as applied to Towns and Buildings.
4th. Public Health Acts, and Rivers Pollution Acts.

Examples of the class of questions proposed to be asked under these heads are appended hereto.

Candidates will be allowed two hours to answer the questions under each of the four heads, and will not necessarily be required to answer all the questions set in each paper, though not less than four must be taken: marks will be given for all questions properly answered. The *viva voce* examination will be held after the written papers have all been sent in, and will be directed to the further elucidation of the answers to the papers on each subject, and to such practical points as fairly arise therefrom.

The Examinations will extend over one or two days, as circumstances may require, and in the latter case the arrangements will be, as far as possible, as follows:—

First day	..	10	to	12	.. Engineering.
„	..	2	„	4	.. Building Construction.
„	..	5	„	7	.. Sanitary Science.
Second day	..	9·30	„	11·30	Public Health Law.
„	..	1	„	4	.. *Viva voce* Examination.

The total number of marks required to constitute a pass will be 50 per cent. in each of the subjects.

Each candidate has to fill a Form of Application, to be obtained from the Secretary.

The fee for each Examination will be 3*l.* 3*s.*, one guinea to be paid on application, and the balance on the day of examination. Should the candidate fail, he will be entitled

to present himself again at the next, or any subsequent Examination, on payment of one-half of the above fee.

No further charge will be made to the candidate than the fees above mentioned.

Candidates that do not present themselves for the Examination forfeit the entrance fee.

Successful candidates will be entitled to receive a Certificate in the form of a "Testamur," signed by the Examiners for the time being, and countersigned by the President and Secretary of the Association in Council.

Further details and particulars may be obtained on application to Mr. Thos. Cole, Secretary to the Association, 11, Victoria Street, S.W.

SUBJECTS OF EXAMINATION.

I.—ENGINEERING AS APPLIED TO MUNICIPAL WORK:

A. Land Surveying and Levelling.
B. Hydraulics.
C. Drainage and Sewerage.
D. Water-Supply.
E. Road-Making.

II.—BUILDING CONSTRUCTION: STRENGTH OF MATERIALS:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building Bye-laws.

III.—SANITARY SCIENCE AS APPLIED TO TOWNS AND BUILDINGS:

A. Ventilation.
B. Sewage Disposal.
C. House Drainage.

IV.—PUBLIC HEALTH ACTS.
RIVERS POLLUTION ACTS.

EXAMPLES OF QUESTIONS.

The following are the Examination Papers set to the candidates at the Third Examination held in London, April 1887, and serve as examples of questions proposed under the different sections.

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

(1.) How are the lines of a chain survey fixed in position, and how is the correctness of the work tested? What is meant by "tying" the lines? Give a sketch.

(2.) How would you find the relative levels of a sloping field, say for laying it out for streets? What instruments are used, and how?

(3.) What is a syphon, and how may it be used in carrying water from one side of a dam to the other? What conditions are essential to its action? Give any instance you know of its use in main drainage.

(4.) What is meant by "Hydraulic Mean Depth," and how is it calculated? What is the H.M.D. of a trough 12 inches square running full?

(5.) Describe the mode of "laying" and jointing an ordinary street sewer pipe, and the use of "boning rods" in securing uniform fall therein.

(6.) Sketch and describe an approved manhole and its proper position and uses in a system of sewers.

(7.) When are brick sewers to be preferred to pipes, and what is their best shape? Sketch section of and specify very briefly for a length of brick sewer.

(8.) Describe and illustrate the mode of forming a reservoir dam, showing how it is made watertight, and the precautions to be taken against leakage and damage by overflow.

(9.) Calculate the strain per square inch on the metal of a

pipe four inches diameter, and one half-inch thick, under a head of 300 feet of water-pressure.

(10.) Mention some of the chief systems of wood paving. Specify briefly for one of them, and state where it is applicable, and why.

SUBJECT:—BUILDING CONSTRUCTION, &C.

(1.) Under what conditions would you construct Inverted Arches in a building—and what purpose do they serve?

(2.) Sketch some different forms of Dowels used in masonry.—Show the position of a Kneestone in a wall.

(3.) Under what conditions would you lay masonry or concrete blocks in Diagonal Bond?

(4.) State Tredgold's, or other rule, with diagram, for proportioning the various parts of a Scarf [having regard to the strength of different timbers] to resist tensional, compressional, or shearing force respectively?

(5.) What considerations determine the form of truss or principal for a roof of a given span?

(6.) Sketch the principal of a roof, not iron, for a span of 26 feet, where a tie-beam is inadmissible?

(7.) What do you consider the best method of forming a fireproof floor for a warehouse? State the advantages and disadvantages of arched floors.

(8.) What is meant by sheet lead "Crawling," and under what conditions will this happen?

(9.) Write a short Specification for flat roof to be covered with zinc, giving such sketches as you consider necessary.

SUBJECT:—SANITARY SCIENCE.

(1.) What are the component parts of—

(*a*) Pure Atmospheric Air?

(*b*) Pure Water?

(2.) What are the usual sources of contamination in a Dwelling House?

(3.) How many cubic feet should be allowed for each Adult in a Sleeping Room?

(4.) What natural conditions and structural precautions are necessary to secure a healthy site for a Dwelling?

(5.) Sketch a section of a House of three stories, showing—

(*a*) A sink on ground floor,
(*b*) W.C. and Bath on first Floor,
(*c*) W.C. on third floor,

and show, distinctly, the water tanks and entire method of drainage, trapping, sewer connection, and ventilation.

(6.) What proportion in sectional area should the ventilating pipe above a W.C. bear to the soil pipe below?

(7.) Describe a practical test to discover any hidden defects in a House drain as to jointing, trapping, &c.

(8.) For what quantity of rainfall in 24 hours is it usual to provide in a main sewer, and how many cubic feet per head of the population would you provide for in a water-carried system of sewerage?

(9.) State the advantages and disadvantages of a duplicate system of drainage for the separation of rainfall from the sewage.

(10.) State, generally, what are the methods adopted for the purification of sewage at the outfall, and describe some one chemical process, its mode of operation and results.

SUBJECT:—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

(1.) (*a*) State the difference under the Public Health Act, 1875, between a sewer and a drain. (*b*) Supposing a sewer existed in a street (which is not a highway repairable by the

inhabitants at large), under what circumstances would that sewer be vested in the Local Authority? and (*c*) how would that affect the power of the Authority to require the owners to construct a new sewer?

(2.) What proceedings are necessary before a Local Authority can proceed to construct a sewer without their district?

(3.) (*d*) Is a Local Authority obliged to remove house refuse from premises and to cleanse privies and ashpits? (*e*) Under what circumstances is a Local Authority liable to a penalty for non-removal? (*f*) What is the amount of the penalty?

(4.) (*g*) Does the Public Health Act, 1875, provide any means whereby a person suffering from the existence of a nuisance caused by an offensive trade being carried on in his neighbourhood can obtain redress without the consent of the Local Authority being required? (*h*) Give particulars as to the mode of proceeding.

(5.) Respecting the making of a new road or street within the district of a Local Authority.

State what proceedings are necessary, as, for instance, majority requisite at a meeting of the Authority, application to Local Government Board or Parliament before the Local Authority can make (*i*) one, (*k*) contribute to the cost of one, (*l*) acquire land to make one with the consent of the owners, (*m*) acquire land to make one without the consent of the owners.

(6.) State the requirements of the Act with reference to contracts. (*n*) What amount can a Committee be delegated to accept? (*o*) At what amount must the agreement be in writing? (*p*) Under what circumstances must advertisements for tenders be made public?

(7.) State shortly the necessary proceedings by a Local Authority against a manufacturer who, in contravention of the Rivers Pollution Act, pours polluted liquid into a

watercourse, such polluted water not being admissible into the sewers of the Local Authority.

Under the present system of appointment to the office of town surveyor those seeking that office must be prepared to work hard to obtain it, and to give up some considerable time to its acquisition. Tact, patience, and perseverance are indispensable qualities when seeking such appointments, and the following suggestions on this matter may be of use.

The appointment usually rests finally with the whole body of the town council or corporation, even if a sub-committee or committee has been appointed in the first case to make some selection of candidates. The candidates thus selected by the committee are usually requested to appear before the whole body of the town council, who then make the appointment from amongst them.

The first thing a candidate should do when he hears of a vacancy occurring in the office of a town surveyor, or sees an advertisement requiring a surveyor's services, is to obtain fresh testimonials from those persons of position and influence for whom he has worked or who know him professionally. These testimonials, with any very good old ones (but not too many of either), should be sent by post to the town clerk or person mentioned in the advertisement, with a formal, carefully-worded application for the appointment.

If canvassing is not prohibited, a list of the members of the town council, with their addresses, should then be procured, to whom printed copies of the application and testimonials should be sent, accompanied by an autograph letter asking that the application and testimonials should be read.

This should be followed up (if possible, immediately), by a journey to the town and a personal visit to each member of the council or corporation, not necessarily for the purpose of soliciting a vote, but with a view to making the acquaintance of the members of the corporation and to identify the appli-

cant with his testimonials ; and in these visits great tact and patience are necessary. It is also of importance to seek and obtain all the outside influence that is possible, in order to bear upon the members of the corporation, by means of letters of introduction, and informal testimonials as to eligibility for the appointment, and personal character and position, &c.

Canvassing on behalf of oneself is extremely unpleasant and harassing work ; but wrong as the system may appear to be, it is not easy to see how, in municipal government, any other method can be adopted, and the visit of the candidate to each member gives the latter an opportunity of asking him questions and satisfying himself as to his qualifications, and thus he will not feel he is acting blindly when he gives his vote in favour of that candidate whom he thinks, after a personal interview, the most suitable for the appointment.

CHAPTER III.

THE SURVEYOR'S DUTIES.

IT will be observed on reference to the list of the duties of the surveyor, given in the preceding chapter, that the first on the list is as follows:—

"To have charge of the repairs of all highways, and to perform all duties devolving on the council as surveyors of highways."

The necessity for these duties are obvious when we turn to the Public Health Act 1875, and read the following sections:—*

"Every urban authority shall within their district, exclusively of any other person, execute the office of and be surveyor of highways, and have, exercise, and be subject to all the powers, authorities, duties, and liabilities of surveyors of highways under the law for the time being in force, save so far as such powers, authorities, or duties are or may be inconsistent with the provisions of this Act; every urban authority shall also have, exercise, and be subject to all the powers, authorities, duties, and liabilities which by the Highway Act 1835, or any Act amending the same, are vested in and given to the inhabitants in vestry assembled of any parish within their district.

"All ministerial acts required by any Act of Parliament to be done by or to the surveyor of highways may be done by or to the surveyor of the urban authority, or by or to such other person as they may appoint" (38 & 39 Vic. c. 55, s. 144).

* For full particulars and explanations of the various Highway Acts see 'The Powers and Duties of Surveyors of Highways and of other Authorities with regard to the Management of the Public Highways,' by Alex. Glen, M.A., etc.

"All streets being or which at any time become highways repairable by the inhabitants at large within any urban district, and the pavements, stones, and other materials thereof, and all buildings, implements, and other things provided for the purposes thereof, shall vest in and be under the control of the urban authority. The urban authority shall from time to time cause all such streets to be levelled, paved, metalled, flagged, channelled, altered, and repaired as occasion may require; they may from time to time cause the soil of any such street to be raised, lowered, or altered as they may think fit, and may place and may keep in repair fences and posts for the safety of foot-passengers. Any person who without the consent of the urban authority wilfully displaces, or takes up, or who injures the pavement, stones, material, fences, or posts of, or the trees in, any such street shall be liable to a penalty not exceeding five pounds, and to a further penalty not exceeding five shillings for every square foot of pavement, stones, or other materials so displaced, taken up, or injured; he shall also be liable, in the case of any injury to trees, to pay to the local authority such amount of compensation as the court may award" (38 & 39 Vic. c. 55, s. 149).

The duties thus devolving upon the town surveyor by reason of these sections and the orders of the council are very considerable. The following table gives a list of the principal subjects which will require his attention; all of which will be considered in due course in this book.

List of Duties devolving upon a Town Surveyor as "Surveyor of Highways."

(1.) The construction and maintenance of highways or streets, including—

(*a.*) Roads formed of broken stones or "metal," commonly called macadamised roadways;

(*b.*) Tar-macadamised roadways.

(*c.*) Streets paved with granite cubes or setts;

(*d.*) Streets paved with wood;

(*e.*) Streets paved with asphalte.

(2.) The construction and maintenance of footwalks or footpaths, including the different materials of which these are formed.

(3.) The breaking of stone for road metal.

(4.) Steam rolling.

(5.) The necessary notices and specifications under the 150th Section of the Public Health Act 1875, for the purpose of compelling private streets to be properly sewered, levelled, paved, metalled, flagged, channelled, lighted, and made good.

(6.) The lighting, cleansing, and watering of streets.

(7.) The naming and numbering of streets.

(8.) The planting of trees along the sides of footwalks.

(9.) Obstructions caused by builders' rubbish or by hoardings and scaffold poles; and also by dangerous or defective cellar coverings.

(10.) The damage caused to footpaths by allowing water from private premises to flow over them, and the nuisance caused by defective rain-water gutters or shutes.

(11.) The damage caused to roadways by the laying or removal of gas and water mains and services, and the surveyor's powers and duties in connection therewith.

(12.) The importance, especially in old towns, of laying down improved building lines of frontage in the narrower or crooked streets.

(13.) The examination of all plans of proposed new streets or buildings.

(14.) The supervision of all new streets and buildings whilst their construction is in progress.

(15.) Dealing with all buildings in a condition dangerous to the public.

(16.) Dealing with all dangerous "holes" and dangerous "quarries."

Each of the foregoing list of duties will be dealt with in separate chapters in addition to other matters which will be treated, but before closing this chapter a few words upon the subject of "meetings" may be of use.

It will be observed upon reference to the list which I have given of the duties of the surveyor, that there is one which says, "To attend all meetings of the board, and committee meetings, except where his attendance has been previously dispensed with; to attend upon the chairman when so required."

The result of this order is that a very large percentage of the surveyor's time has to be devoted to attendances at long meetings of the board or town council, and at the numerous committee and sub-committee meetings which are appointed under it.

This work is doubled where, as in most towns, th corporation and their committees sit in a dual capacity, viz. as the council proper, and the council as the urban sanitary authority; this often involves two ordinary meetings of the whole body each month, and probably at least six committee meetings a week, leaving the surveyor but scanty time to look properly after his works.

With regard to these committee meetings it is necessary that each should have some distinguishing title descriptive of the class of work over which it has jurisdiction, and in selecting names for them the following list may be of some service:—Finance Committee, General Purposes Committee, Law and Parliamentary Committee, Surveyor's Committee, Land and Estates Committee, Rates and Taxes Committee, Streets Committee, Lighting and Cleansing Committee, Navigation of Port Committee, Public Grounds Committee, Sanitary Committee, Drainage and Sewerage Committee, Markets Committee, Properties for Sale Committee, Works Committee, Water Committee, Gas Committee, Watch Committee, Health

Committee, Library, Museum and Arts Committee, Baths Committee, Parks, Gardens, and Improvement Committee, Streets Improvement Committee, Insanitary Properties Committee, etc. etc.

The surveyor should always endeavour to be punctual in his attendance at the Council meetings and those of the committees, as to be late is always looked upon with disfavour. His reports should as much as possible be in writing, so that there should be no misunderstanding as to what his advice is on any subject. To save trouble and expense it is well that all drawings of new schemes should be first submitted to a committee in pencil, as they are frequently much altered; this is very vexing if they have been neatly and highly finished. It must not be forgotten that the gentlemen who form municipal bodies give their time gratuitously, and everything should be done to save it as much as possible. It is an excellent plan and a great convenience, if a surveyor will have a series of named and numbered pigeon-holes in his office corresponding to his committees, in which to place all papers, drawings, correspondence, etc., which he intends to bring up to the next meeting of a committee; thus saving himself flurry at the last moment before the meeting, in endeavouring to find the papers he wants. With his varied duties, correspondence, interviews, meetings, inspections, investigations, reports, drawings, and calculations, the motto of a surveyor's office should be "method."

CHAPTER IV.

TRAFFIC.

BEFORE a surveyor can decide upon the best material with which the streets of his town shall be paved, it will be well to consider the question of the class of traffic they will have to bear.

It must be remembered that three distinct interests have to be considered in dealing with this question, viz. (1.) The ratepayers, upon whom the cost of construction and maintenance of streets falls. (2.) The owners and employers of horses and vehicles who principally use the streets; and (3.) The inhabitants of the adjoining premises, who would be annoyed if the materials selected were unduly noisy or dirty. In addition to these considerations, much depends upon local circumstances; the class of trade upon which the welfare of a town is dependent must not be lost sight of. A pavement suitable for a busy, pushing manufacturing city may not be suitable for a quiet agricultural or cathedral town, or for a town which is used as a health resort. Again, the question of the most adaptable materials must be considered, and the climate and physical character of a town should enter largely also into this question.

To condense the requirements of a good roadway into as small a compass as possible, the following may be given as some of its principal requisites :—

(1.) It must not be extravagantly costly in its first construction.

(2.) It must be durable, and require the least possible amount of repairs at the least cost.

(3.) It must be safe, firm and hard, with an even face and yet giving sufficient foothold to horses.

(4.) It must be as noiseless as possible.

(5.) It must be so constructed as to be quickly laid down and repaired when broken up for water, gas, drains, or other purposes.

(6.) It must be of strong foundation, so as to carry the heaviest weight without subsidence.

(7.) It must be of such a shape as will throw off all surface water at once.

(8.) It must be of such materials as will make a minimum of dust or mud.

(9.) It must be easily cleansed.

(10.) It must be non-absorbent of impurities or moisture of any kind.

(11.) It must give easy traction upon its surface.

(12.) It must not cause jolting to the traffic.

(13.) It must not injure horses' legs or hoofs.

Of the above requirements No. 1 affects the ratepayers alone; Nos. 3, 11, 12, 13, affect the traffic only, except that the occupiers of shops are indirectly affected by them; No. 4 affects both traffic and occupiers, and No. 10 affects the occupiers principally. The remainder of the requirements affect all three interests.

With reference to the wearing effect of traffic upon the surface of the roadway, no standard has yet been arrived at by which this can be determined with accuracy. In France a great number of observations and experiments have been made from time to time by the engineers of the Ponts et Chaussées, but their practice has been to count the number of "collars" passing a given section of a roadway in a given time, irrespective of the weights, speeds, or number of wheels such collars may be drawing. Mr. Deacon, formerly Borough Engineer of Liverpool, has, however, reduced traffic to a standard of tons per yard width of roadway per annum. This he effected by having the traffic in any street carefully watched for a certain definite time, the number of vehicles,

their character and approximate weight being noted as well as the number of horses by which they were drawn, and their number of wheels.

The effect of the traffic thus tabulated, arranged and reduced to ton-yards per annum, can be ascertained upon any roadway, and Mr. Deacon has given the results of his observations in a valuable paper on the subject of street carriage pavements which he read before the Institution of Civil Engineers.*

Sir John MacNeill has estimated that 80 per cent. of the total wear of a road is due to traffic, the remaining 20 per cent. being due to atmospheric causes. Of this 80 per cent., 66 per cent. he considers is due to the action of horses' hoofs where the traffic is fast, and 44·5 per cent. where the traffic is slow. General Morin estimates the wear of a road due to horses' feet to be two-thirds of all causes. There can be no doubt that the action of horses' feet, shod as they are with heavy iron shoes with long toe-pieces and heels, must have a destructive effect upon the surface of a carriage-way, and this may be. easily observed when watching the ruts formed by any continuous line of traffic in a roadway.

The following remarks from a report of the Society of Arts on this subject may here be of interest. "It may be "mentioned that as respects the horses' shoe, attention has "long been called to its defects by Sir Francis Head and "others; but Sir Joseph Whitworth now points out the achieve- "ment of a decided and important improvement, which will "have a large effect in road conservancy, as well as the reduc- "tion of noise. The improvement consists in the fastening of "a rim of hardened steel, of about half-an-inch square, to the "horse's feet, and letting the frog grow to its natural size. "One effect is to reduce by five-sixths the weight of the old "shoe, or in other words to reduce by five-sixths the weight

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii.

"of the iron hammers constituted by the common horse's "shoes, pounding the road surface, and creating road dust and "dirt, and distributing it about. The saving in this respect, "as well as the reduction of noise by the reduction of the "weight of rim, and also the saving of road wear, would "warrant the imposition of the stimulus of a tax, or a toll, "upon heavy horses' shoes to hasten their removal." *

Up to the present date, however, no general change has been effected in the manner of shoeing horses, notwithstanding these admirable remarks of Sir Joseph Whitworth upon the subject.

With reference to the question of traction upon roads, General Morin, in his 'Expériences sur le Tirage des Voitures,' states that the resistance to the rolling of vehicles upon solid metalled roads and pavements is proportional to the weight, and inversely proportional to the diameter, of the wheels. On solid roads he states that the resistance is nearly independent of the width of the tires when they exceed 3 or 4 inches, but on a compressible face it decreases in proportion to the width of the tire; the resistance further increases with the velocity on hard roads, but does not do so when they are soft.

The following table is almost universally now adopted as showing the traction upon level roads formed of different materials, asphalte being taken as the standard of excellence in this respect.

Asphalted roadway	1·0
Paved roadway, dry and in good order	1·5 to 2·0
,, ,, in fair order	2·0 ,, 2·5
,, ,, but covered with mud	2·0 ,, 2·7
Macadamised roadway, dry and in good order ..	2·5 ,, 3·0
,, ,, in a wet state	3·3
,, ,, in fair order	4·5
,, ,, but covered with mud ..	5·5
,, ,, with the stones loose ..	5·0 ,, 8·2

* *Vide* 'Report of the Society of Arts on the application of Science and Art to street paving and street cleansing of the metropolis, 1875.'

There are four forces constantly at work tending to destroy the momentum of vehicles passing along a roadway: they are gravity, collision, friction, and the resistance of the air.

The first of these is lessened by easy gradients in a road, the second can be overcome to a great extent by evenness of surface, the third by hardness, and the fourth, as well as all the others, by giving sufficient foothold to the animal drawing the vehicle.

Another excellent table,* prepared from experiments made by Mr. Amos on different descriptions of pavement in the City of London, may be useful, and is here given:—

Road Material.	Speed in Miles per hour.	Draught in lbs.	Fraction of Load.	Tractive Force in Decimals of the Load.
Gravelly Macadam in a side street	6·945	126·6	$\frac{1}{45·3}$	·0219
	3·45	114·322	$\frac{1}{50·3}$	·0197
Granite pitching by side of tramway	5·15	70·963	$\frac{1}{81·1}$	·0123
	3·196	41·932	$\frac{1}{137·3}$	·0072
	2·557	47·572	$\frac{1}{121}$	·0082
Granite Macadam "freshly laid"	4·239	262·886	$\frac{1}{21·9}$	·0456
	2·775	242·726	$\frac{1}{23·7}$	·0421
Asphalte Pavement ..	5·025	91·525	$\frac{1}{64·9}$	·0158
	3·56	69·753	$\frac{1}{82·5}$	·0121
	5·687	84·268	$\frac{1}{68·3}$	·0111
Wood Pavement ..	3·932	118·163	$\frac{1}{48·7}$	·0205
	3·278	102·412	$\frac{1}{56·2}$	·0177
	3·827	100·066	$\frac{1}{57·5}$	·0173
Macadam road, very good on Victoria Embankment	6·65	109·06	$\frac{1}{52·7}$	·0181

* Ibid.

The following table from Law's 'Rudimentary Treatise on Civil Engineering' shows the force required to move a load of a ton weight on different descriptions of roadway, the limiting angle of resistance, and the greatest inclination which should be given to the road being also stated.

Description of the Road.	Force in lbs. required to move a ton.	Limiting angle of resistance.	Greatest inclination which should be given to the road.
		° ′	
Well laid pavement	33	0 50	1 in 68
Broken stone surface on a bottom of rough pavement or concrete	46	1 11	1 „ 49
Broken stone surface laid on an old flint road	65	1 40	1 „ 34
Gravel road	147	3 45	1 „ 15

As a matter of fact, however, the gradient of a macadamised road should not, if possible, exceed 1 in 20,* experience having shown that a horse, unless the hill is a very long one, is able to draw his ordinary load for a level up such an inclination, whereas, if it is steeper he is sometimes stopped altogether, even though the carter tries the zigzag route so as to obtain an artificial ease of gradient.

The table given in 'Molesworth' upon the same subject is too well known to be repeated, and another table may be found in Sir Henry Parnell's work on roads, which gives a comparison between the draught necessary on a well-paved road at 2, on a well-made, clean macadamised road at 5, whereas on a wet and muddy gravel or flint road it rises to 32!

* Experiments made by the direction of the French Government on the tramway between Sèvres and Versailles, showed that a horse on a level tramway draws three-and-a-half times the weight, at the same speed and with the same expenditure of power, that he can do on an ordinary road. Up a gradient of 1 to 100, he is capable of drawing 2·25 times the weight he can do up the same gradient on an ordinary road, and up a gradient of 1 to 25 he can draw one-and a-half times the load he can do under similar circumstances on the ordinary road.

Mr. T. D. Hope, of Liverpool, assuming the power of traction at 100, gives the following table:—

	Weight drawn.
Level macadamised road	27 cwt.
„ granite pavement	30·5 „
„ wood	54·75 „

And Lieut. Crompton has given the resistance of wheels in lbs. per ton on different surfaces as follows:—

Very good pavement	35 lbs.
Good macadam	60 „
Ordinary ditto	90 „
Newly-laid gravel	200 „
Soft grass land	300 „
Newly-laid metal	440 „

Here "newly-laid metal" comes out very badly, and points to the necessity of rolling, of which I shall speak in a future chapter.

Whilst on the question of wheel resistance, it may be well to note that the small front wheels of a waggon cause considerably more harm to a macadamised road than the larger hind wheels. In the smaller diameter any loose stones or obstruction is pushed along in front for a considerable distance, often tearing up the surface of the road, whereas in the other case the stone is forced into its place or crushed as under a roller.

With reference to this question of traffic a few words upon the Highways and Locomotives (Amendment) Act, 1878 will not be out of place.

Section 23 provides that where extraordinary expenses are incurred by an authority in repairing their roads by reason of excessive weights or extraordinary traffic passing over them they may recover the expense from any person by whose order such weight or traffic has been conducted.

This clause has not been very generally acted upon, as

there seems to be some difficulty in proving the damage or extraordinary cost.

In order to meet some of these difficulties Mr. Taylor, the Borough Surveyor of Barnsley, read a very interesting paper on the 17th of June, 1882, at a district meeting of the Association of Municipal and Sanitary Engineers and Surveyors held at Goole.*

In order to arrive at an approximation of the damage caused by traction engines Mr. Taylor prepared the following table:—

Progressive No.	Weight of Traction Engine.	Dimensions of Driving Wheel.	Dimensions of Front Wheel.	Weight of each Empty Waggon.	Average Weight of Load in each Waggon.	Dimensions of Waggon Wheels.	Dead Weight on Roads of Traction Engines at rest.	Dead Weight on Roads of loaded Waggons at rest.
							Per sq. inch.	
	Tons.	ft. in. in.	ft. in. in.	Tons.	Tons.	ft. in. in.	lbs.	lbs.
1	9	7 0 × 17	4 0 × 12	2½	5	3 9 × 6 3 3 × 6	347	700
2	8	5 6 × 15	3 4 × 10	1½	3	3 9 × 6 3 3 × 6	359	420
3	7	7 0 × 15½	3 6 × 8½	2½	4	3 7½ × 8 3 4½ × 8	326	456
4	10	7 0 × 17½	4 0 × 9	3	7	3 1 × 9½ 3 5 × 9½	423	606
5	6½	5 6 × 16	3 6 × 10	1½	6	3 5 × 5½ 4 4 × 5	280	800
6	8	5 4 × 16	3 0 × 9	2	3	3 0 × 6	359	464
7	6½	5 6 × 10	3 6 × 10	2	3	3 0 × 9½	364	295

Then having found that the extra amount of repair to his road had cost £105 12*s.* 6*d.*, he apportioned this amount out amongst the eight traction-engine owners as follows:—

* *Vide* 'Minutes of Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. viii. page 79.

Name of Owner of Traction-Engine.	Number of Journeys.	Tonnage.	Amount apportioned.
			£ s. d.
a	1260	36,540	62 4 7
b	120	3,760	6 8 4
c	360	11,060	18 16 8
d	180	5,400	9 4 2
e	180	4,860	8 5 5
f	5	.. ..	.. ..
g	20	400	0 13 4
h	5	.. ..	.. ..
Total	.. ..	62,020	105 12 6

Space will not permit me to give all the details necessary to arrive at the above results, but Mr. Taylor finishes his admirable paper with the following suggested amendments to the Act :—

That the term "extraordinary traffic" shall mean and include the carriage along the highways, by means of ordinary team labour or by road locomotives, of all goods or merchandise, foreign to or not directly connected with the staple trades or industry of the district of the particular authority of the highways traversed; or the carriage of goods and merchandise along the highways of any authority by means of road locomotives, no matter whether the same shall have been licensed to travel by the proper authority or not.

Section 32 to be amended so as to confer upon every highway authority power to make, alter, and repeal bye-laws for the regulation of road locomotives, such bye-laws to be subject to the approval of a central highway authority to be formed in London, and to grant licences to road locomotives to travel through their district by any highway authority, provided always that in case of the refusal of any local authority to grant such licence, the reason for such refusal shall be at once communicated by the local to the central authority, who shall have power, if they think such reasons for the refusal unfair, to require the local authority to grant a licence.

Section 23 to be amended so that the charge for extraordinary traffic may be levied by a charge of any amount, not exceeding one penny per ton per mile of macadamised highway traversed, or not exceeding threepence per ton per mile of paved highway traversed; or by the difference between the cost of repairs for ordinary and extraordinary traffic.

The term "excessive weight" to mean the weight of any road locomotive, empty or loaded cart, wain, or waggon drawn on any highway, greater than is allowed in the 28th section of this Act, or in the above-mentioned bye-laws. Cases of traffic by excessive weight to be dealt with summarily before the magistrates and treated as misdemeanours.

At a meeting of the Association of Municipal Engineers and Surveyors held at Liverpool in 1890, Mr. J. H. Burton, surveyor to the Auldenshaw Local Board, read a paper on "Traction Engines and Their Effect upon Roads and Buildings," and after speaking of the great damage caused to roads by the wear and tear of traction engines and the heavy loads they drag, he brought to the attention of the members at the meeting a new system of wheels fitted with Boulton's patent springs which, he said, caused absolutely no damage whatever to the roads, and that vibration was reduced to a minimum; and so favourable was the opinion of the Ashton-under-Lyne Town Council to this form of wheel that they passed the following resolution: "That no travelling fee be "charged for traction engines with Boulton's patent spring "wheels passing through the borough, except in the event of "actual damage being done."

"The Mayor, in moving the confirmation of the minutes, "said the Council would see from one of the minutes that the "committee had agreed to accept, without cost, traction engines "fitted with Boulton's patent spring wheels. They found that "these wheels did little or no damage whatever, and they "thought it would pay them better to admit these engines than

"admit other traction engines with the ordinary wheels at the "usual payment."

The description given of these wheels is as follows:

The driving wheel (which was formerly the principal cause of the damage to the roads and the vibration complained of) is about 7 feet in diameter and 16 inches on the face. The periphery of the wheel is divided into 68 cells or compartments, about 6½ inches square and 9 inches deep. In these cells or compartments hard wood blocks are loosely fitted, so that they will move easily about, with the grain of the wood pointing outwards, each block being bound round with an iron strap about three-quarters of an inch from the end. The blocks are bedded on an indiarubber or other pliable cushion about 5½ inches square and 1 inch thick. The blocks are loosely attached to the wheel by a bolt let into the wood block several inches, the head of which is covered by a wooden plug, and which bolt passes through the indiarubber or other cushion, and is secured on the inner rim of the wheel by a nut. As the wheel revolves, the weight comes on three, four, or five of these blocks, as the case may be. The indiarubber or other washer gives way, the bolts are pushed up, the blocks adapt themselves to the surface of the road, and have very much the effect, as has been described, of the putting down of an elephant's foot.

On the question of "safety" to traffic, Mr. Haywood, the eminent Surveyor of the City of London, has caused several most complete observations to be made from time to time, the results of such observations being detailed by him in various reports. Amongst other useful information compiled by him, he has ascertained that a horse will travel 446 miles upon a roadway paved with blocks of wood without a fall, 191 miles upon asphalte, and 132 miles upon granite setts. I cannot do better than give verbatim his remarks upon this point:—

"Slight rain makes both asphalte and wood more slippery

than they are at other times. On asphalte the slipperiness begins almost immediately the rain commences; wood requires more rain before its worst condition ensues. The slipperiness lasts longer upon wood, on account of its absorbent nature, than it does upon the asphalte; when dry weather comes after the rain, then asphalte is in its most slippery state, and the horses fall on it very suddenly; on wood their efforts to save themselves are more effectual; wood also is frequently in that peculiar condition of surface in which horses slip or glide along it without falling. A small quantity of dirt upon asphalte makes it very slippery, wood requires a large quantity. Slipperiness can be temporarily cured on both pavements; on the asphalte by sprinkling it with sand, on the wood by sprinkling it with gravel. The result in both cases is dirt. The sand thrown on asphalte helps to wear it out, the gravel thrown on wood tends to preserve it. When a horse falls on asphalte it has difficulty in getting up; on wood it rises more readily." *

In streets crowded with traffic, the constant stopping and starting, especially on any surface that is slippery, is very trying to horses. Attention has frequently been directed to this point with a view to the storage of some power in a vehicle, either by the compression of a spring in stopping, or by some other mechanical means, in order that in starting the driver may at will liberate this power so as to assist the horse in overcoming the inertia of his load. These trials, however, have not at present met with much success.

Before closing this chapter on traffic, it will be well to point out that nearly all vehicles travelling rapidly can pass each other safely if allowed a clear space of eight feet; hence all roadways should, if possible, be made of a width between the kerbs of some multiple of eight: a convenient width for

* 'Report on Accidents to Horses on Carriageway Pavements,' by William Haywood (1874).

the footpaths, so far as foot-passenger traffic is concerned, is found to be one-fifth of the entire width of street. It is scarcely necessary to add that vehicles pass each other on the left side, pedestrians on the right. It is not easy to assign a cause for the former, beyond custom, except that the whip is held in the right hand, and in consequence free play is given for its use, as the driver sits on that side and can watch his wheels in passing. In France and other countries the right side is the "rule of the road." In the case of pedestrians it is perhaps more convenient for many reasons to pass on the right side, one being that the umbrella or parasol is always carried in the right hand, which is also used to remove the hat when bowing, and another because one's tendency in passing any obstacle is to give way with the left shoulder. For regulating the traffic and for the protection of foot passengers, "sanctuaries," as they are termed, have often to be constructed by surveyors in broad streets or awkward centres of traffic, and it is well to place a lamp-post on these sanctuaries, on which may be advantageously fixed a notice, "Keep to the Left," so as to regulate vehicular traffic. On the lamp-posts at the edge of the footpaths it is also sometimes customary to fix small enamelled iron plates bearing the inscription on both sides, "Keep to the Right," so as to regulate the pedestrian traffic.

Of the danger to life and limb to pedestrians in London much has frequently been said, and no wonder, when we consider the number of persons who are daily injured, and sometimes killed, according to the Registrar-General's returns.* Some years ago it was proposed to erect light iron

* From a 'Return of the Number of Accidents known to Police which occurred in the Streets (of the Metropolis) during the year 1890,' I find that the number of persons run over by vehicles and killed was 144, and that for the same period the number of persons run over and maimed or injured was 5,584!

bridges over the most dangerous crossings, approached by winding stairs, but "time is money" in the mighty metropolis, and the scheme was abandoned because it was felt that most persons would prefer the risk of being run over rather than spend the time in ascending and descending the necessary steps for this purpose.

CHAPTER V.

MACADAMISED ROADWAYS.

I DO not propose in this work to speak of any of the engineering operations necessary to lay out or construct long lines of connecting roadways, as that is a duty which seldom falls to a town surveyor to perform, and there are a great number of treatises and books upon the subject already published. The object of this chapter will be to give some information and hints upon the construction and maintenance of what are known as macadamised roads, suitable for urban and suburban traffic.*

There can be little doubt that roadways of this description are expensive luxuries where the cost of their maintenance, owing to excessive traffic or other causes, exceeds 2*s.* per square yard per annum, but they are often necessary luxuries when the requirements of the locality are considered, a point to which I drew attention in the preceding chapter upon "Traffic." For purposes of what may be styled "pleasure traffic," macadamised roadways are unequalled when well constructed and maintained; but there are many objections to them, which will be considered in their place in this chapter.

The word "macadamised" is, as is well known, derived from one John Loudon Macadam, who in the year 1816 first took

* The following is a list of the "Road Authorities" at present existing in this country. The Imperial Parliament. County Councils. County Boroughs. Boroughs. Urban Local Boards. Rural Local Boards. Single Parishes without Local Boards. Grouped Parishes formed into Highway Boards. Road Trustees (almost entirely defunct).

up the question of putting broken metal upon a road instead of the boulders previously used.* His name being rather a peculiar one, has been attached to this description of road ever since.†

As a matter of fact, the "macadamised" roadways of the present day are constructed after a method introduced by Thomas Telford, as an improvement upon Macadam's principles, and a perusal of the two following specifications will, I think, show that there is not very much difference between the method introduced by Telford and that followed at the present time.

Specification of a Roadway as designed by Thomas Telford more than fifty years ago.‡

"Upon the level bed prepared for the road materials, a bottom course or layer of stones is to be set by hand in form of a close, firm pavement; the stones set in the middle of the road are to be seven inches in depth; at nine feet from the centre five inches; at twelve feet from the centre four inches; and at fifteen feet three inches. They are to be set on their broadest edges lengthwise across the road, and the breadth of the upper edge is not to exceed four inches in any case. All the irregularities of the upper part of the said pavement are to be broken off by the hammer, and all the interstices to

* The first road "engineer" in this country was John Metcalf of Knaresborough, who was born in 1717, and who, although totally blind, was the first person to introduce a methodical system of road repairs. *Vide* 'Roads and Road Makers,' by Henry Alexander Glass.

† "The name of Mr. Macadam deserves a few remarks for other reasons than "its present popularity. The public naturally look to him as a sort of magician, "and his invention, as it is thought, as something preternatural. If his own "name had not been macadamisable into a verb, it is probable that his roads "would have been little known. He did not invent the method in question of "breaking stone because it had long been the practice of Sweden, Switzerland, "and other countries, and was long known to every observing traveller. (*Vide* "The Westminster Review,' vol iv. page 354.)

‡ *Vide* 'A Treatise on Roads,' by Sir H. Parnell (1833).

be filled with stone chips firmly wedged or packed by hand with a light hammer, so that when the whole pavement is finished there shall be a convexity of four inches in the breadth of fifteen feet from the centre.*

"The middle eighteen feet of pavement is to be coated with hard stones to the depth of six inches. Four of these six inches to be first put on and worked in by carriages and horses; care being taken to rake in the ruts until the surface becomes firm and consolidated, after which the remaining two inches are to be put on.

"The whole of this stone is to be broken into pieces, as nearly cubical as possible, so that the largest piece in its longest dimensions may pass through a ring of two and a half inches inside diameter.

"The paved spaces on each side of the eighteen middle feet are to be coated with broken stones or well-cleaned stony gravel up to the foot path or other boundary of the road, so as to make the whole convexity of the road six inches from the centre to the sides of it, and the whole of the materials are to be covered with a binding of an inch and a half of good gravel free from clay or earth."

If the above specification, written more than fifty years ago, is compared with one of the present date, it will be seen that there is a strong resemblance between them.

Specification of a Roadway as now executed.

The cross section of the roadway when finished is to be an arc of a circle, with a rise of 1 in 27 from kerb to the centre of the roadway each way.† The roadway, when consolidated and finished, to be 12 inches in depth at the gutters and 15 inches at the centre, diminishing gradually from this

* The total width of roadway being thirty feet.

† It is necessary to give a new roadway more convexity than it will have when finished, for however carefully it is raked or attended to when being rolled, the top is sure to flatten and spread towards the haunches.

point right and left to the depth named. The gutters to be 2 feet in width, formed of stone setts 6 inches by 6 inches, and laid in sand, on a firmly consolidated surface of small broken stone or gravel.

The earth road-bed on which the surface formation is to est is to be excavated to the required depth, and when graded and shaped to its proper form, it is to be thoroughly and repeatedly rolled with a steam roller, and all depressions which then appear are to be filled with the same material as the road-bed, and rolled until the whole be uniformly compact and firm.

On the road-bed thus formed and compacted, a bottom layer of stone of a depth of 8 inches at the centre of the road, and gradually diminishing to 6 inches at the kerb, is to be set by hand, to form a close, firm pavement. The stones are to be laid, with their largest side down, in parallel lines across the street, breaking joint as much as practicable.* The width of the upper part of the stone not to be more than 8 inches, nor less than 6 inches. The stone not to exceed 15 inches in length. After being set closely together, the stones are to be firmly wedged by inserting a bar in all possible places, and placing between them stones as nearly as possible of the depth of the pavement, until the whole is bound in position. Projections of the upper part of this course are to be broken off, care being taken not to loosen the pavement; and no wedging is to be done within 20 feet of the face of the work being laid. The small interstices are to be filled in with stone chips firmly wedged with hammers. The whole is to be thoroughly rammed and settled to place, and all undue irregularities of surface broken off.

On the foundation course must be laid an intermediate layer of broken stones, varying in size from 3 inches in their

* Instead of parallel lines it is sometimes well to place these stones diagonally from centre to kerb, or "herring-bone" fashion, thus greatly facilitating the under drainage.

greatest diameters to 1 inch in their smallest diameters. These irregular-sized stones may be either the "tailings" of the screened stones, or may be raked from the quarry, and placed on the roadway without being machine-broken; but they must nevertheless be so laid as to compact solidly, and must be clean broken stone, free from dust and dirt, and within the dimensions given above. This intermediate course must be 4 inches in depth at the centre of the roadway, gradually decreasing to 3 inches in depth at the gutters; it is to be thoroughly rolled with the steam roller until it be firm, compact, and solid. On its upper surface it must be identical in rise and form to the cross-section of the finished pavement, as specified above. In the laying of this course of stone a small quantity of binding material is to be used, sufficient only to fill up the crevices, and render this portion of the pavement solid. Preferably the binding is to be of fine screened gravel or sand, which is to be sufficiently watered during the process of rolling, so that the "licking up" of the road material, and its adherence to the rolling-wheels may be prevented.

On the intermediate course is to be laid the surface layer of broken stone.* It must be 2½ inches in depth, and the stones must be practically uniform in quality, and as near an approach to a cube in form as possible. Each stone used in this layer must have passed through a 2½-inch circular hole, and all stones that are wedged-shaped, and do not approach uniformity of measurement on their sides, are to be taken from the road with properly shaped rakes, and no stones allowed to remain which are not sound, strong, and equable in size and quality of material. The stones are to be raked into an even layer, and the steam roller passed over them twice or thrice. After this a quantity of fine screened gravel or sand is to be thrown on and sufficiently sprinkled to

* In metalling a road it is better to put on the coats gradually, than to give the whole thickness of metal at once.

moisten the mass without "licking up." The rolling is then to be continued (working the roller backwards and forwards, gradually from the gutter to the crown), with an occasional light watering of the pavement, until the cross-section be exact according to specification, the interstices filled in, the roadway firmly compacted and solid, and all excess of binding removed from the surface of the finished pavement."*

Telford's object was the complete separation of the road metal from the subsoil by a firm and regular foundation, and this system has ever since held its ground. The advantages to be gained in constructing a roadway in this manner may be summed up as follows :—

(1.) Economy of construction, as a considerable quantity of metalling is saved ; only 3 inches of properly broken stone and a little binding material being necessary, the foundation of the roadway (which really carries the traffic) may be made of a quality of stone unsuitable for road metal, or even of bricks or stones from old buildings that are being pulled down.

(2.) The prevention of the rising up or "spewing" of the clay or other soft material on which the roadway rests.

(3.) A solid foundation is secured which will successfully resist the weight and percussion of the traffic.

(4.) The increased facility for the drainage of the roadway water being ruinous to it.†

* The method adopted in Chicago, U.S.A., for forming their roadways is as follows :—The road bed is prepared of the proper contour and well rolled with a 15-ton steam roller until it is even, firm, and compact ; on this bed rubble stone is carefully placed by hand with its broadest surface downwards, then 12 inches of metal are added 6 inches at a time, thoroughly rolled to bind it well ; it is then topped with 4 inches of crushed trap rock or some other equally hard stone, which will not disintegrate through the action of the weather, nor pulverise under the pressure and wear of vehicles upon it ; this is again thoroughly well rolled so as to compact and bind it together.

† "If roads be kept dry they will be maintained in a good state with proportionally less expense. It has been well observed that the statuary cannot saw his marble, nor the lapidary cut his jewels without the assistance of the powder of the specific materials on which he is acting ; this, when combined with water, produces

Instead of forming a paved or "pinned" foundation for macadamised roadways, sometimes what is called "hard core" is placed at the bottom of the road upon the surface formation."

This "hard core" is made of very heterogeneous materials, often the waste products of the house refuse depôt, and consists of ashes, old pots and pans, meat tins, old bottles, shells, and a variety of similar articles; sometimes the core is made of burnt ballast, but in no case does it make so good a foundation as stones set by hand.

Concrete has also been employed as a foundation with great success, but it is very expensive, and is seldom used except under streets paved with either granite, wood, or asphalte, of which I shall speak hereafter; for if the traffic was so great as to necessitate the use of concrete for a foundation it would surely be better to give the roadway a more durable surface than macadam.

The following table, showing the thickness of the foundation and metalling of broken stone roads, is from a paper on roadways, read to the Association of Municipal and Sanitary Engineers, by Mr. James Hall, Borough Surveyor of Stockton, and may be of use to those who would like to know what proportions to use:

	Pinned Foundations.			Broken Stones.		Concrete.	
	Pinning.	Covering.	Metal.	Under.	Upper.	Concrete.	Metal.
	In.	In.	In.	In.	In.	In.	In.
Country roads.. ..	6	3	4	9	4	4	3
Suburban ,, ...	9	3	5	9	6	6	5
Town streets	9	6	5	15	6	10	5

sufficient attrition to accomplish his purpose. A similar effect is produced on roads, since the reduced particles of the materials, when wet, assist the wheels in rapidly grinding down the surface."—Parnell's 'Treatise on Roads,' 1883. More modern writers have likened macadamised roadways to "stone mills on which the stones are ground into dust when dry, or mud when wet."

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	£	£	£	£	£	£	£	£
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	Cost of Mud per acre.	Traffic per Annum per yard in width.
	In certain parts.	Tons.
[illegible]	344	25,000
[illegible]	500	50,000
[illegible]	1666	25,000
[illegible]	4000	500,000

The following is a table of the cost of streets in Paris per square yard per annum:†

Description of Pavement.	Maintenance.	Cleansing.	Total.
	s. d.	s. d.	s. d.
Stone Pavement	0 4·40	0 3·37	0 7·87
Macadam	0 9·25	0 7·31	1 5·26
Asphalte	0 10·20	0 4·17	1 2·37

* Vide 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lx.

† Vide 'Annales Industrielles de Paris,' Oct. 21st and Nov. 4th, 1877.

The cost of maintaining macadamised roadways as compared with that of granite setts has been said to be as high as 5 to 1, and that this cost if capitalised for 12 or 13 years will equal the first expense, interest on money, and the necessary repairs for a granite paved roadway.

The following table gives the cost per annum per square yard for the maintenance of macadamised roadways in different places, so far as I have been able to collect them:

	s.	*d.*		*s.*	*d.*	
Brighton		6	to		9	
Bristol		4	,,	1	0	
Charing Cross (London) ..				5	0	(now paved)
Exeter		6	,,	2	6	including cleansing
Glasgow					8½	
Leeds		10	,,	1	2	
Liverpool		2	,,	2	6	nearly all streets now paved
Manchester		6	,,	1	8	do. do.
Merthyr Tydfil					4½	
Newcastle				1	3	including watering
Paris		9¾	,,	10	9	
Parliament Street (London)				3	6	repairs only (now paved with wood)
Regent Street (do.)				3	7	(now paved with wood)
Stockton		9	,,	1	6	
Sheffield	1	8	,,	2	0	
Wakefield				1	0	(all paved streets now)

In Birmingham the macadamised streets have worn down 6 inches in one year, with a traffic of 2484 vehicles passing in 10 hours.

The only way to obtain any reliable data as to the comparative cost of maintenance of any description of pavement, is to reduce the traffic by actual observation to a unit of weight at per yard, width of street per annum, and then standards could be arrived at in this way:

Roads with a traffic of less than 10,000 tons per annum per yard of width.

Roads with more than 10,000 and less than 30,000.

Roads with more than 30,000 and less than 50,000 and so on.

With reference to the great cost of maintenance in Paris, the following particulars * may here be given :

"The surface of the street is picked by gangs of men, metal from 2½ to 9 inches in thickness is then laid on, a coating of sand it then spread upon it, it is watered and rolled at per kilometre-ton, that is, at per ton weight of roller per kilometre travelled, at a cost of about 15·33*d.* per ton-mile for the first 250,000 ton-miles, and at reduced rates for additional service. The materials used for the roads are flints costing 4*s.* 6½*d.* per cubic yard for light traffic roads ; for medium traffic, hard millstone at 11*s.* 4*d.* ; and for the heaviest and greatest traffic, porphyry at 15*s.* 9*d.* The average total cost of maintenance of the streets is 1*s.* 8½*d.* per square yard per annum for the first-class roads, and 1*s.* 1½*d.* for the lighter traffic ; the highest cost for maintenance is as high as 10*s.* 9*d.* per square yard, the lowest 9¼*d.* per annum."

It may be well to mention that 73 per cent. of the streets in Paris are paved, 5 per cent. are coated with asphalte, and 22 per cent. are macadamised.

The contour, or best form of cross section that should be given to a roadway, has often exercised the minds of engineers, but for all practical purposes evenness of surface and regularity of section in a macadamised roadway are of more importance than the slight difference between straight lines and curves, which might only tend to confuse the workman. Formerly it was the practice to employ a complicated gauge in the form of a straight-edge fitting with plummet or level and sliding bars, but a good eye, assisted by a long straight-edge and spirit-level and three boning rods, is generally found to be sufficient, and if the centre of the roadway is kept level with the heel of the footpath, a sightly cross section is generally the result ; or say 6 inches to 9 inches higher

* *Vide* 'Annales industrielles de Paris.'

in centre of a roadway 30 feet in width between the kerbs, 3 inches to 4 inches where it is from 18 to 20 feet in width. A good rule to remember is that the height of the *versed sine* of the section should be one sixtieth of the width between kerbs.

The following detailed section of a macadamised roadway is one which I am in the habit of specifying for suburban

districts, as it is easily set out and constructed, and answers all purposes most admirably.

The total width of street is 36 feet, of which the roadway takes 24, leaving a footpath 6 feet in width on each side.

The surface of the finished roadway is a segment of a circle, the crown being level with the heels of the footpaths on each side; the formation surface is parallel with it, and of course the depth of this and the thickness of foundations and metal must depend upon local circumstances. It will be seen that the haunches are drained with 3-inch common drain-pipes. This may be omitted if the ground is thoroughly dry, but it is often a great help to a road.

The paths, kerbing, and channeling will be described in their respective chapters.

It must be borne in mind that on a perfectly level road a more convex section is necessary than on a gradient.

It is wrong to make the sides of a roadway weaker than the centre, especially in streets with shops on each side, or on hills where drags are likely to be used. On hills, too, be it

remembered, the channels should take the surface water; any ruts from wheel tracks acting as watercourses are disastrous. Hauling timber on a macadamised roadway is also very damaging.

The great objections to macadamised roadways are as follows:—

(1.) They manufacture too much mud and dust.*

(2.) They are too absorbent.

(3.) They are very noisy and damaging to vehicles and horses when fresh metalled.

(4.) They constantly require mending, but never seem quite sound.

(5.) They are frequently encumbered by men and carts engaged in either repairs, cleansing, or watering.

(6.) They are very expensive to maintain and cleanse.

(7.) They are bad for a horse to fall upon, as such falls generally damage their knees.

The following notes upon the maintenance of macadamised roadways may here be of service:—

(1.) Roads should be inspected in wet weather, as hollows and other imperfections are then easily detected; a hollow place extends very rapidly if neglected.

(2.) All ruts should be filled in at once. If there are three parallel, the centre rut should be first filled in; the traffic is thus slightly diverted, as a horse will avoid new metal.

(3.) Ruts should not be allowed to form; the surface of the road ought never to lose its regular section.

(4.) A road should be thoroughly repaired directly it shows the least sign of being fairly worn all over.

(5.) The right season of the year for repairs is the autumn, although where a steam roller can be used almost any time

* A report of the Paddington Vestry on "wood and other pavements," (1878) states macadam as a mud producing material is twelve times worse than wood, and six times worse than granite cubes.

will do. If the surface of the road is very hard it should be "lifted" * previous to repairs.

(6.) All loose stones should be picked off at once or put together in hollow places upon the roadway, as, if allowed to remain, they are not only dangerous to horses, but are liable to be crushed, or to be forced through the skin of the roadway, thus causing it damage.

(7.) Water lodging upon a road does great mischief, but it should not be let off by digging a trench with a pickaxe to the side of roadway, as is sometimes done.

(8.) A roadway when very dry sometimes suffers through disintegration of the surface.

(9.) Scraping the mud off a roadway may damage it by loosening stones; sweeping the surface when wet is best.

(10.) A heavy shower does a road good by washing it; a continuous drizzle, especially after frost, is very ruinous to a roadway.

* This is also sometimes called "stocking" or "chequering," and consists of making furrows across a roadway with a sharp pickaxe, about a couple of inches in depth, thus removing any irregularities, and also allowing the new metal to bed properly. Mr. Rutty the contractor has invented a machine which he calls a "Scarifier" to perform this work. It consists of a solid mass of iron weighing about two tons. At either end are three square holes, into which are inserted three massive teeth or tines, which project downwards at an angle of about 45 degrees. Powerful screws elevate or depress the apparatus as occasion may require. When required for use, the three tines are inserted at one end, and a traction engine being attached, a start is made, when the tines penetrate the ground and turn up the surface to a regular depth of 1½ in. to 4 in. as required. The scoring is not, as with the pick, across the road, but in line with it. The first line is run close to and parallel with the channel, and when the desired length of road has been traversed, the tines now present themselves to the work at the opposite end of the scarifier, which is drawn back again. In this way it is claimed that the entire breadth of the road, or, if need be, only one-half of it, is quickly scarified. The inventor states that by these means an area of 2000 square yards or more can be broken up in a day, and that the cost is about 75 per cent. less than with hand labour. When it is considered that a man can do with a pick only two square yards an hour, or about twenty a day, it is evident that the "scarifier" is very valuable in lessening the time for the repair of a road, if it accomplishes what the inventor claims for it, and the author understands that the machine is much used in the metropolis and its vicinity with excellent results.

(11.) A good cleansing is sometimes worth a coat of metal.

Upon the question of Road Maintenance, the "Roads Improvement Association," have issued some useful instructions to Road Foremen and Labourers, copies of which can be had gratis on application.

Tar Macadam Roadways.

In some Towns in England Bituminous or Tar Macadamised Roadways are formed, and for light traffic they answer their purpose admirably if care is taken in their construction; the *modus operandi* may be explained as follows:—

The material to be used may be the ordinary local road metal broken to three sizes, viz., 2½-inch gauge, 1½-inch gauge, and 1¾-inch gauge.

These are heated on an iron floor, under which are flues from a fire, until all the moisture is driven out of each piece of stone.* The material is then mixed in its heated state with a sufficient quantity of a mixture (also in the heated state) of pitch, tar, and creosote oil boiled until they form a thick and tough consistency, the stone and mixture are thoroughly incorporated together by frequent turnings until each particle of stone is thoroughly coated and even slightly impregnated with the tar mixture. The quantity of the tar, pitch, etc., depends on the quality of these articles, especially that of the tar, which frequently varies; a good average may be however taken as follows:—

12 Gallons of Tar
½ Cwt. of Pitch
2 Gallons of Creosote Oil
1 Ton of Stone.

* Another method is to heat the road metal by making a heap of it mixed with small coal or "slack," setting fire to it and allowing the heap to burn out. This is, however, not very satisfactory, as a quantity of cinders are thus mingled with the metal.

The longer the treated stone is allowed to remain before being put on the road the better, but it is well in this case, to again treat it with some of the mixture before taking it to the road.

The road bed and foundation are prepared in a similar manner to that for an ordinary macadamised roadway, and the tarred macadam is laid down as follows; the first layer is made with the 2½-inch metal, about 3 inches thick, and well rolled with a 15-ton roller; upon this is laid the 1½-inch metal, about 2 inches thick, also well rolled, and the top coat is made with the ¾-inch metal about one inch in thickness, sprinkled over with sharp sand or grit and thoroughly well rolled and consolidated.

The cost of this work varies with the price of materials in different localities from 2*s.* to 3*s.* per square yard, exclusive of the cost of foundations.

For further information upon this subject I refer my readers to the remarks and specifications of the late ever to be regretted Mr. Joseph Gordon, M.Inst.C.E., and to the specifications and remarks of other engineers carefully tabulated by Mr. H. U. McKie, M.Inst.C.E., which will be found in the Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors, vol. x. page 53.

Dry weather is essential whilst this class of roadway is in course of construction, and the work will require careful watching, as, upon the skin becoming broken, the whole roadway soon breaks up. Such roads have, however, many advantages over ordinary macadamised roadways when finished, not the least of them being their imperviousness to moisture, and the ease with which they are cleansed.

Before closing this chapter it may be convenient to refer, in a short and concise manner, to a few other methods of paving street carriage-ways, as these methods are not of sufficient importance to devote a separate chapter upon the subject.

Bricks.

Brick pavements have not been largely used in this country. They might be adopted instead of stone or wood blocks in cases where they were easily procurable, and where neither of the latter could be had.

They should be laid on edge, with their joints grouted in cement or bitumen, on a proper concrete foundation. As however, their edges, or arrises, are somewhat brittle, it might be better to lay them close together without joint.

There is danger, however, that such a pavement would wear unevenly owing to the varying quality of the bricks, and this has been found to be the case where they have been used on footpaths; notably at Brighton, where this class of foot pavement is rapidly dying out in favour of flags, asphalte, or concrete.

In San Francisco a new street pavement has been tried; it is called "hydro-carbolised brick," and consists of bricks of a soft porous nature boiled in coal tar, which it is *said*, renders them tough and hard. On the prepared road bed a layer of bricks are placed flat-wise, each brick being dipped in boiling tar as it is laid. This is overlaid by a second course of prepared bricks, placed close together edgeways. The interstices are then filled with boiling tar, and the whole covered with a thin layer of screened gravel.* I cannot recommend this form of pavement.

India-rubber.

India-rubber in large sheets, about one inch in thickness, has recently been introduced in Hanover as a material with which to pave roadways, but I have not seen it, nor can I give any particulars of the manner in which it is laid. It is said to be as durable as granite, perfectly noiseless, and

* Journal of the 'Society of Arts,' vol. xxii. page 123.

unaffected by either heat or cold, and that it is not in the least slippery, all of which is possible, but it must be very expensive.

There is a small sample of india-rubber pavement to be seen at the entrance to the L. & N. W. Euston Railway Station. These sheets of india-rubber are held down at their sides upon a concrete foundation by strips of iron, which clasp the edges tight on each side. The effect of these small pieces of india-rubber pavement is excellent, and if it could be applied in a more general manner at a price which was not prohibitive, perhaps the road pavement of the future is to be found in this material.

A short length of "Busse's Caoutchouc Beaten Asphalte or India-rubber pavement," has been recently tried in the City of London, and was laid in the carriageway of King William Street, between Nicholas Lane and Cannon Street.

Mr. Haywood the Engineer to the Commissioners of Sewers thus describes it * :—"the material of which this pavement is composed, is said to be obtained from the chemical treatment of the residue from the Scotch shale oils, mixed with powdered limestone, and laid in the form of a heated powder, in a similar manner to the compressed Asphalte in ordinary use, the thickness when finished, being about 2¼ inches.

"The pavement was laid in August last, the then existing concrete foundation being re-used, after being properly faced. Some slight repairs have been done to the pavement in January of the present year."

* *Vide* 'Report on the Works Executed during the year 1890,' by William Haywood.

CHAPTER VI.

ROAD METAL AND BREAKING.

THE only true test of the fitness of any stone for use as a road metal is by an experimental trial upon a certain length of roadway; but in making the first selection for such trials it is well to make the following investigations:—

(1.) Ascertain from local persons, such as masons, quarrymen, and others, their opinion of the qualities of the stones in the neighbourhood.

(2.) Make a trial of the stone for toughness. This can be done by setting a good stone-breaker to work upon a heap of the stone as quarried and carefully watching how much he can break in an hour.*

(3.) Ascertain what power the stone has to resist abrasion. This is done in France by putting the broken metal into a revolving cylinder and then carefully noting by weight what the cubes lose by contact with each other. Another plan may be adopted by pressing the stone against a grindstone with a uniform pressure, and noting the loss caused by such contact.†

* Toughness is not all that is required. Leather would be very difficult to break with a hammer, but it would not make a good road metal.

† A little laboratory for testing paving materials has been established in Paris, and one or two new tests have been devised. Besides the chemical analysis of asphalts and other substances, and the usual tensile tests of cements, material for macadamising is tried by means of a simple machine, consisting of two hollow cylinders of sheet iron fastened together, and revolving on a common axis. To estimate the resistance of any stone to the rubbing and wearing of a macadamised

(4.) The power to resist compression may be easily ascertained by placing small cubes in a hydraulic press and noting under what pressures each cube will crush.

(5.) The effect of weather is not easily ascertained artificially, although it is suggested that a good test may be made by soaking the stones in a saturated solution of sulphate of soda; and then on exposure to the air, if soft, it is said the stone will disintegrate, as if under the action of thaw succeeding frost.*

The specific gravity of a stone is no criterion whatever as to its fitness. Clay-slate has a higher specific gravity than a tough flint, and yet the former is almost useless as a road metal; the latter, on the contrary, often making excellent roadways.

The qualities necessary for a really good road metal are hardness or power to resist abrasion, toughness, not easily decomposed or affected by the weather, strength to resist

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road under traffic, one cylinder is filled with broken pieces of stone, of the size and form used for roads, and the other with an equal weight of similar pieces of a standard stone, a certain hard porphyry. The coupled cylinders are then revolved for a considerable time. The axis of rotation is oblique to the axis of figure, so that the pieces of stone not only rub upon each other, but are tossed about, and strike each other with hammering blows. The result of this is to wear off the surface into dust. When the process has been carried on long enough, the cylinders are opened, and the dust in each is collected and weighed, the amount of dust from the new stone under test, compared with that from the standard stone, giving, by inversion, its comparative value as a road material. The average of at least three tests is taken as the coefficient of resistance to wear for that material, and observations are also recorded on the character of the mud produced by mixing the dust collected with water, as some stones when used for road metal give in rainy weather a much more slippery mud than others. Stone for block pavements is tested by cutting it into cubes, which are pressed against a revolving disc of cast-iron. A similar cube, also of cast iron, is pressed against the disc at the same time, with equal force, and at the same distance from the centre of rotation. Both cubes are weighed before the operation begins; and when the cast iron is worn away to an appreciable extent, both cubes are weighed again. The loss of each, in proportion to its whole weight, shows the resistance to wear of the stone, compared with cast iron, but the coefficients are reduced to that of a certain hard sandstone, taken as unity.

* I have tried this experiment, but without success, except on such soft stones as were evidently unfitted for use as a road metal.

compression, and at the same time the stone when broken ought to have some power of cohesion without the necessity of much binding material. The question of cost I put aside at once, as it is well known that the best road metal is always the cheapest where there is much or heavy traffic.

Local circumstances must to a great extent determine what stone to use upon a roadway, but the following list may be of use:—

Syenite.—This is a granite in which horneblende takes the place of mica, and is an excellent road material; the darker the colour the more durable it is found to be.

Granite.—This should have more felspar than quartz, and have as little mica as possible; the closer the grain the better. Coarse-grained granites soon decompose.*

Trappean Rocks.—Some of these are excellent for road metal. Basalts of dark colour and close grain should be selected. Greenstones with similar characteristics are good; as is also Whinstone.

Gneiss.—Is inferior to granite; it has mica in layers and is not a good road metal.

Clay Slates.—These are useless, as they crumble on exposure or degenerate into mud.

Limestone.—The Metamorphic, Silurian, and Carboniferous limestones may be used if crystalline in appearance, but the Lias and Oolitic are of little use.†

Sandstone.—Some of these, if cherty or containing a large

* All granites are not suitable for road making. When a granite becomes weathered the felspar may decompose into kaolin or China clay. The commencement of this alteration is indicated under the microscope by the turbidity of the felspar. At the quarries it is often necessary to reject large quantities of stone for road purposes because of this change. All the toughness is gone out of it, and the quarrymen speak of it as "dead."

† Many hundreds of miles of roadways in this country are made with limestones; they often make an excellent surface, as they possess a considerable power of binding together, but weather and very heavy traffic affect them considerably; as they all have a strong affinity for water, their very power of thus cementing themselves together causes a quantity of dust in dry, and mud in wet weather.

percentage of iron, may be used; but as a rule they are quite unfitted for use as a road metal. *

Flints.—These, if tough, make excellent roadways; but unfortunately they are sometimes too brittle for heavy traffic. Surface-picked flints are better than those from a quarry. †

Pebbles.—These are found on sea shores and river beds. They are composed of very various rocks, and are much water-worn and rounded; when broken they sometimes answer very well if mixed with gravel to bind them.

Gravel.—This, if of a flinty character, and not too much mixed with earthy matter, makes good roads for light traffic, if carefully watched or well rolled during formation. Pit gravel should always be screened through wire screens of 1½ and 1¾ gauge, and the small can be used for footpaths.

In some places it is difficult to obtain any natural stone for the purposes of road metal; in these cases slag from blast furnaces or ordinary clinkers from furnaces are sometimes used. Oyster shells are used on the roadways near the Gulf coasts, ‡ and charcoal in Michigan, United States. § I have myself made a most excellent roadway with coral on the coast of Jamaica, and no doubt many strange materials have been, and still are, used for this purpose.

"I never mix" is an adage that should be followed by surveyors as regards road metal. Do not mix a soft material with one that is harder for either construction or maintenance of a roadway; the effect is what is known as a "bumpy" road, arising from the fact of the soft stone wearing faster

* The late Prof. Ansted, writing concerning roads, said it was well to remember "that sandstone is better than limestone, and hard limestone better than slate, while basalts and granites are exceedingly good or exceedingly bad, according to the proportion of alkaline earths (especially soda) which they contain."

† A flinty or quartzose stone seems to harden with exposure. This is notably the case in pebbles; old pebble paving taken up and broken makes a most hard and durable road metal.

‡ 'Roads, Streets and Pavements,' by Q. A. Gillmore, p. 10.

§ Ibid.

than the hard. The hardest metal should be kept for the top or surface layer of the roadway.

As an instance of the extreme difficulty besetting the question of the best material for road metal, I will here give a table showing the comparative coefficients of quality assigned to them by the engineers of the French Department of the Ponts et Chaussées.*

COEFFICIENTS OF QUALITY OF ROAD MATERIALS.

Granitic gravel	23·8
Quartz gravel	21·4
Trap	20·0
Quartz	10·0 to 25·0 (in one instance 4·8)
Basalt	12·0 ,, 20·0
Porphyry	10·0 ,, 20·0 (in one instance 5·0)
Quartzite	11·0 ,, 18·0
Devonian schist	16·0
Schist	4·0 to 12·0
Sandstone	12·0 ,, 16·0
Granite	6·0 ,, 20·0 (generally 10·0 to 12·0)
Syenite	12·0
Gneiss	9·0 to 12·0
Siliceous pebbles and gravel	8·0 ,, 19·0 (in one instance 6·0)
Silex	8·0 ,, 16·0
Chalk flints	7·0 ,, 11·6
Siliceous limestone	6·0 ,, 18·0 (generally about 10·0 to 12·0)
Compact limestone	14·0
Magnesian limestone	16·0
Carboniferous limestone	9·0
Oolitic limestone	5·0 to 12·0
Lias limestone	5·0 ,, 10·0
Jurassic limestone	5·0 ,, 8·0
Limestone	5·0 ,, 12·0
Mean of all France	10·63

It will be seen by the above table how different are the results obtained from materials of the same character. The French engineers also made experiments upon the materials in the following table, taking 20 as excellent, 10 sufficiently good, and 5 bad.

* *Vide* 'The Maintenance of Macadamised Roadways,' by Thomas Codrington, p. 33, a most excellent work upon this subject.

Material.	Wear.	Crushing.
Granite	7·3 to 18·0	7·7 to 15·8
Syenite	11·6 ,, 12·7	12·4 ,, 13·0
Chalk Flints ..	3·5 ,, 16·8	17·8 ,, 25·5
Limestone	6·6 ,, 15·7	6·5 ,, 13·5

Syenite comes out pretty level all through, while the other materials given show great fluctuations of value, both as regards wear and as regards crushing.

Breaking stone for the purpose of using it as a road metal was, until comparatively recent years, always effected by hand; now, as in other cases, machinery has stept in and somewhat supplanted manual labour. Hand-broken road metal, however, still finds favour with road surveyors; it is better broken, and in some districts, the occupation finds employment for persons who otherwise would be thrown on the rates for support.

In breaking stone by hand the breaker sits and strikes the stone with a small, cast-steel, chisel-faced hammer, weighing about one pound, at the end of a long, straight-grained but flexible ash stick.* The breaker also has another hammer, weighing about five pounds, with which he reduces the size of the large stones before breaking them into the proper size for road metal. This latter size is often a matter of choice, some engineers preferring it to be broken so small as will pass through a ring of only $1\frac{1}{2}$ inch in diameter; others are content with 3 inches, especially where the roads are steam rolled. An old method of gauging used to be "such a size as the stone breaker could put in his mouth," but this was a varying gauge and unsatisfactory to all persons concerned, and "to pass all ways through a ring of $2\frac{1}{4}$ inches internal diameter" is now the size very often adopted. Upon this subject I cannot do better than quote Mr. Ellice-Clark's

* Mr. W. Bold considered a hammer weighing $1\frac{1}{4}$ lb. of an elliptical form, pointed at the ends, the area of each end being about $\frac{1}{100}$th of a square inch, to be the most suitable to break hard stones. *Vide* 'Minutes of Proceedings Institution of Civil Engineers,' vol. i. (1840) p. 50.

remarks in a paper he read before a district meeting of the Association of Municipal Sanitary Engineers and Surveyors at Hanley in 1886 :—

"Some difference of opinion exists as to the sizes to which stones should be reduced for metalling a road. There is a prevailing opinion that all stones should be broken to pass a gauge of 1½ inches. The writer ventures to express the opinion that this is an error; all the hardest stone, like granite, trap rock, basalt, the Devonshire dolorite and similar rocks should be broken to a smaller gauge than flints and the hardest limestone, which, in their turn, should be broken smaller than such materials as Kentish rag and stones of a similar character.

"The method of specifying the dimensions of stone should be abandoned for a weight test. Macadam says, 'Every piece of stone put on to a road which exceeds an inch in any of its dimensions is mischievous,' and in most of his specifications he insists on no stone weighing more than six ounces.

"Parnell adopts 2½ inches for the largest dimensions. To within the past few years the latter size was very generally adopted irrespective of the quality of the material. It has been the practice now for upwards of half a century when repairing roads with granite and the harder rocks, to have the stones broken as uniformly as possible. The results of this are that, though the general surface may be in good repair, the road will be full of small rises and depressions, the surfaces of which are also rough, stones rising abruptly above the general surface of the road.

"It is this which causes granite macadam roads to be so unsuitable for light-springed vehicles such as cyclists use. The author has recently been led to investigate the cause of complaints arising from cyclists when travelling over what was apparently a well-kept road, and he has come to the conclusion that it is of as much importance to have stones of different sizes, as it is to have a maximum size. The

proportion of different sizes requires yet to be determined. So far as investigations have gone, he gives the following as closely approximating upon the proper proportions of sizes:—

	Maximum Weight.	Minimum Weight.
Granite and similar rocks	3½ oz.	.. .. ½ oz.
Flints and similar stones	5 ,,	.. .. ⅜ ,,
Limestone and similar stones ..	6 ,,	.. .. 1 ,,

One half of the total quantity to be of maximum weight, one-eighth of the minimum weight, the remaining three-eighths to be composed of stones varying between the maximum and minimum. This brings us to the question of binding materials.

"In a former paper on this subject, published ten years ago, the author stated his conviction that the 'decadence of modern roads commenced with the using of binding material,' the introduction of which was coincident with the use of stones broken to a uniform size. Longer experience has confirmed this, and though in practice he is compelled to use materials to bind (?) roads, he does so very sparingly, and only because of the inability to obtain materials broken to various sizes in sufficient quantity. If the demand is, however, generally set up for proportions of different sized stones, the necessary quantities will soon find their way into the market." *

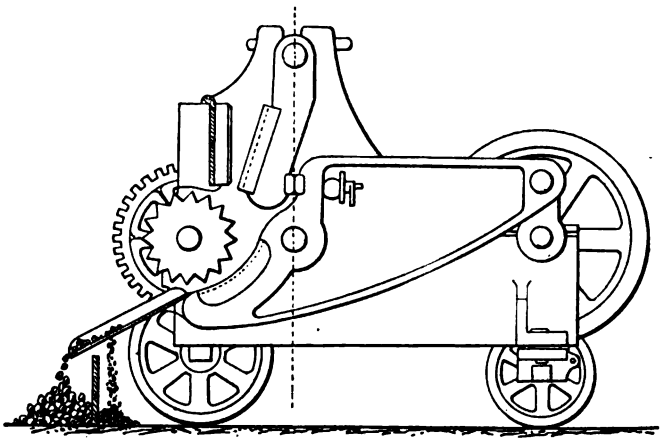
Mr. Codrington says † "a good stone breaker will break 2 cubic yards of hard limestone to the ordinary gauge in a day, and some men will break more. Hard siliceous stones and igneous rocks can only be broken at a rate of 1½ or of 1 cube yard per day; of some of the toughest, such as Guernsey granite, a man can only break on an average half a cube yard per day. River gravel, field stones, or flints, which are already of a small size, can be broken at the rate of 3 or 4 cube yards per day."

This may be taken as fairly representing a day's work; the price for breaking, however, must vary considerably in different

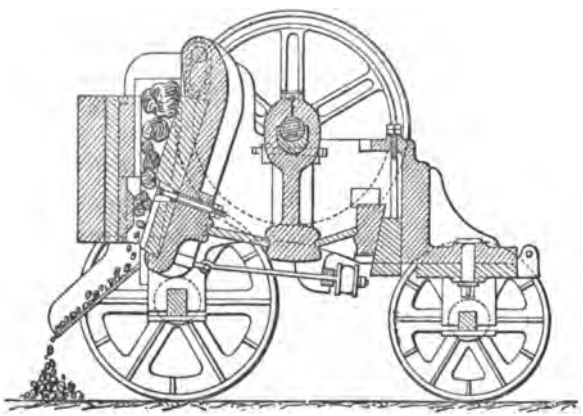
* *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. xii. p. 207.

† 'The Maintenance of Macadamised Roads,' by Thomas Codrington, p. 38.

localities on account of the varieties of the stones to be broken and the value of labour; in some districts the road metal does not cost more than 1*s.* per cube yard, in others 2*s.* 6*d.* and



"ARCHER'S" STONE BREAKER.

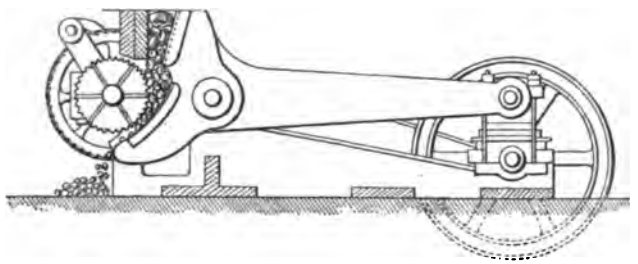


"BLAKE'S" STONE BREAKER.

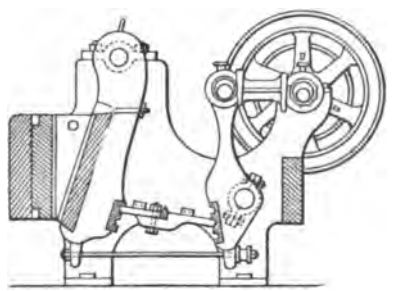
2*s.* 8*d.* is not considered too high, and it was to meet and reduce this great expense that steam stone-breaking machines have been introduced. These machines are known as "Hall and Robinson's," "Broadbent's," "Mason's," "Goodwin and

Busby's," "Ellison's," "Newall and Archer's," "Hope's," "Blake's," and "Baxter's," the latter being those which are best known and most generally used in this country.

The accompanying illustrations will give a general idea of the manner in which the stone is broken or crushed between strong iron jaws; in all cases a revolving perforated screen is necessary (not shown in the drawings) to separate the stone



"NEWALL AND ARCHER'S" STONE BREAKER.



"MASON'S" STONE BREAKER.

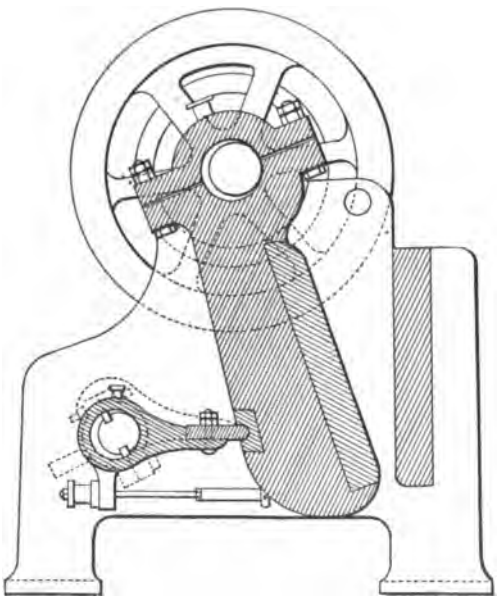
broken to proper gauge from that which is too large, and also from the spalls or chippings.

Mr. Till, the Borough Engineer of Birmingham, speaking of the work done by one of Blake's machines in 1874, says:* "The stone-breaking machine at Holliday Street will break on an average 40 tons of ragstone per day, at a cost, exclusive of wear and tear of machine, of 10½*d.* per ton, but it produces 16 per cent. of dust or fine stone; of the remainder, one-fifth

* *Vide* 'Report of the Borough Surveyor of Birmingham to the Paving and Street Improvement Sub-Committee,' p. 11.

has to be rebroken by hand; the whole is very irregular in size and very flaky in comparison with hand-broken stone. The machine is much more efficient in breaking granites or pebbles. It has, however, been found very useful during the last two years, in consequence of the difficulty of obtaining labour."

Mr. Jacob, the Borough Engineer of Barrow-in-Furness, read an excellent paper on the subject of stone-breaking



THE "ACME" STONE BREAKER.

machinery to the members of the Association of Municipal and Sanitary Engineers, at their meeting in Manchester in 1875,* giving a full description of one of Blake's machines, to which I will refer my readers.

Mr. Codrington† gives the result of breaking whinstone in a 16-inch by 9-inch Hope machine, from which it appears

* *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers, vol. ii. p. 76.

† *Vide* 'The Maintenance of Macadamised Roadways,' by Thomas Codrington, p. 41.

that the total cost, including wages, coal, oil, cotton waste, etc., wear and tear of machinery, and, I presume, interest on first cost of machine, was about 1*s.* per cube yard. This effected a saving of 10*d.* per cube yard as compared with the same stone broken by hand, and the machine broke 40 tons of stone per diem.

To make a stone-breaking machine pay, it is necessary:

(1.) To give it nearly constant work.

(2.) That the stone to be broken shall be too tough to break economically by hand.

(3.) That the machine shall be at the quarry, so as to save the expense of much handling.

(4.) To exercise care in feeding, to give it a sufficient supply without allowing an undue quantity of stone to pass in at one time.

(5.) As about 20 per cent. of grit or dust is produced, this must be used for foot-paths, or as a binding material for roads, or in asphalte or tar paving.

In addition to the grit which is produced, a great many long and thin pieces of stone pass through the machine, which have to be again broken by it before they could be used as road metal; and having once taken this form, they will frequently pass several times through the machine before they get properly broken.

The wear and tear of a stone-breaking machine is very considerable, as can be easily imagined; it has been known to reach as high as 62·5 per cent.* of the first cost of the machine in one year. The objections to stone-breaking by machinery are principally:

(1.) In some districts labour can be successfully employed in this manner.

(2.) Hand-broken stone is sharper in fracture, as it is done by a blow and not by gradual pressure, whereas machine-

* *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers,' vol. ii. p. 82.

broken stone is often flaky or with rounded edges, and frequently each stone may be cracked and shaken by the pressure.

(3.) Want of uniformity in the size of the stones.

The smaller the stone is broken the heavier a cubic yard of it will weigh, as the percentage of vacant space between each stone will be less. It has been found by experiment, however, that 55 per cent. of ordinary road metal is solid, so that the weight of a cubic yard of it can easily be ascertained in the following manner.*

Multiply the weight of a cubic foot of any stone by 27 to bring it to a cubic yard, and then multiply this by 0·55: the result will be the weight of a cubic yard of the same stone when broken for metalling.

A cubic yard of Guernsey granite broken to pass through a 2½-inch ring has been weighed, and gives an average of 1 ton 3 cwt. 2 qrs.

	tons	cwt.	qrs.
A cube yard of flint weighed	1	1	3
,, ,, pit gravel weighed	1	4	3
,, ,, limestone weighed	1	3	0

A cubic yard of ordinary broken road metal will, when properly spread, cover an area of about 30 square yards of surface of a roadway.

The following specimen specification for the supply of stone either unbroken or broken may be of use.

Specification for the Supply of Road Metal.

(1.) The road metal must at all times be clean and free from clay or other dirt, and fully equal to the sample; if required to be broken, each cube must have a square face and sharp edges, and pass all ways through a 2-inch ring.†

(2.) The metal must be delivered in (*name of town*) free of

* *Vide* 'The Maintenance of Macadamised Roadways,' by Thomas Codrington, p. 45.

† The size is dealt with in preceding remarks in this chapter.

all charge to the corporation, either at a railway station, or at one of the depôts of the corporation, at the option of the contractor, such option to be declared in the tender.

(3.) The metal must be supplied on the order of the borough engineer in such quantities as he may specify, and must be delivered within the time specified in the order. The contractor shall not be required to supply and deliver more than tons in any one week ; but the corporation will be at all times ready to take the metal in larger quantities.

(4.) The bill of lading or railway invoice shall be taken as *primâ facie* evidence of the weight of metal supplied ; but the corporation retain the right to test the accuracy of such bill of lading or railway invoice, by passing the metal over a weighbridge as it is received.

(5.) Metal delivered at a depôt by carts shall be measured when broken and paid for at the rate of cwt. per cubic yard.

(6.) The corporation retain the right to reject all metal which shall not be equal to the sample, or at their option to pay a reduced price according to its value.

(7.) Quarterly payments will be made by the corporation on the certificate of the borough engineer, and within one month from the date of such certificate.

(8.) The borough engineer shall be the sole judge as to the fitness of the metal supplied, and his certificate, in writing shall be conclusive evidence upon the point as between the corporation and the contractor.

(9.) If the contractor shall make default in the supply and delivery of road metal in accordance with the terms of this specification, and within the time specified for the purpose in the order of the borough engineer, the corporation shall be at liberty to obtain such road metal as they may deem fit and necessary from another source, and any excess in price or other loss they may consequently incur, shall be recoverable by them from the contractor as liquidated and ascertained damages.

(10.) Tenders must be sent in only on the prescribed form, and the person tendering must insert in his tender the name of two persons who will join him in a joint and several bond to the corporation in the sum of . for the due performance of the contract.

(11.) Each person tendering must send to the office of the borough engineer a sample of the road metal he offers, accompanied by a full description, and the name and position of the quarry from which it is produced; such sample to be not less than one cwt. in weight, and to be retained by the corporation in the event of the tender being accepted.

(12.) The corporation do not bind themselves to accept the lowest or any tender; and they further retain the right to reject a contractor in the event of his failing to find sureties to their satisfaction in compliance with the 10th condition.

(13.) The word "corporation" shall mean the mayor, aldermen and burgesses, of in their capacity as the urban sanitary authority for . The word "contractor" shall mean the person whose tender is accepted, and who has signed these conditions; and the words "borough engineer" shall mean the engineer to the said corporation for the time being.

CHAPTER VII.

ROAD ROLLING.

THE march of civilisation has decided that road rolling is a necessity for macadamised roads, instead of allowing the stones of which they are composed to be worn in by the traffic, as was formerly the custom. In Calcutta bullock rollers were used so long ago as the year 1855, and it was the cruelty of this operation that suggested to Mr. W. Clark the necessity for a steam roller,* the outcome of which was the well-known roller as manufactured and supplied by Messrs. Aveling and Porter of Rochester, and now so generally used throughout this country, as well as in America and other foreign towns.†

Steam rolling saves money as well as suffering, and the legislature have recognised the importance of a sanitary authority becoming possessed of a steam roller by permitting money to be borrowed for the purchase of a roller as for a permanent work. (Sect. 234 Glenn's Public Health Act 1875, footnote to sub-sect. (1).)

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 95. (The first steam roller was made in the year 1864.)

† The steam roller, like many another invention, was the result of "evolution," the first attempt of the kind having been made in Liverpool in 1866, when a heavy horse roller was dragged along by an ordinary traction engine. From this emanated a complete steam roller which weighed 30 tons, and was in use for some time in Liverpool, when it had to be abandoned, principally on account of the great width of the rollers, which would not conform to the contour of the carriage-way.

Mr. Albert W. Parry, the late Borough Surveyor of Reading, has prepared some tables on the subject of steam road rollers, from information he received on this subject, in answer to some questions he addressed to the surveyors of a number of towns a few years ago. It appears from this tabulated statement that thirty-three 15-ton steam rollers were in use, six 10-ton rollers, one 21-ton roller, one 8-ton roller, one 9½-ton roller, one 14½-ton roller, one 17-ton roller, and one 25-ton roller; this latter not being much used, as it was found to be too heavy.

The average gross cost per annum of necessary repairs to the rollers, other than those which could be effected by the men in charge of it, amounted to 35*l.* 12*s.* The number of men employed to attend to the roller and cost of labour per day varied considerably, from one case (South Shields) where "one engine-man at 26*s.* per week, and an old scavenger with the flag" were found to be sufficient; to another (Gloucester) where the cost per day is stated as follows: "one man works the engine at 5*s.* per day, one boy with signal flag 1*s.* 8*d.*, two men spreading gravel or sand at 3*s.*, two men watering and sweeping to keep water from running off in channels."

Some of the older rollers require a steersman as well as a driver, and the Highways and Locomotives Amendment Act 1878 requires two men with flags, but this is seldom really necessary. The sweepers, spreaders and sprinklers should be taken as irrespective of the actual cost of the roller, which may therefore be assumed to be the wages of the engine-man, say 5*s.* per diem, and a boy or old man with a flag at 2*s.*, thus making a total for labour of 7*s.* per diem.

The fuel that is consumed by a 15-ton roller seems to be from 3 to 5 cwt. of coke per diem, common gas coke being generally used, though steam coal would no doubt answer equally well, some of the smokeless Welsh descriptions being of course necessary.

With regard to the question "When not used for rolling roads, to what other use (if any) do you put the engine power?" there were not many towns that use the machine for any other purpose than rolling, but the following uses may be enumerated to which the machines have been applied — Driving a stone-breaker, a mortar-mill, a saw-bench, a chaff-cutting machine, a bean-crusher, etc. It has also been used in connection with pumping, and to produce the necessary power for the electric light, and it is frequently employed as a traction engine.

The driving rollers usually have provision by which spikes may be fitted into holes in their faces, in order that they may be used for lifting or chequering roads. These, however, apparently do not answer; the working of a machine in this manner is said to shake and strain it considerably, and the holes in the rollers, which are plugged with wood when not in use, are objectionable, as these plugs wear out and the road metal gets into the holes, and the surface of the road is picked up as the rolling proceeds; besides this, the spikes seem to have no effect unless the surface of the roadway being operated upon is soft.

With reference to the use of binding material, the most commonly used and that which receives most favour is road grit or scrapings;* sharp sand is also employed, as well as gravel if clean, and also stone chippings and screenings; these should be of the same material of which the road is made, if possible, and no doubt newly constructed roads require more care in the binding material than simple repairs. The steepest gradient upon which a roller will act appears to be 1 in 9 in Blackburn, with a 15-ton roller, but this must require a very heavy pressure of steam, and 1 in 14 seems to be a gradient that gives no trouble to roll either up or down; in going down hill, of course it is a mere question of sufficient break power.

* This should be collected and "weathered," so as to get rid of mud and any organic matter in it.

The number of superficial yards rolled per day must vary extremely with circumstances: the class of material, the amount of binding and water used, the gradient and pressure of steam maintained, and the amount of rolling considered necessary, being amongst the various influences.* From the above returns I find that the number of square yards rolled varies from 500 to 3000 per diem, the average for 42 towns being 1105 square yards per diem.

The cost per square yard rolled, including all charges, may be assumed to be between ½*d.* and 1*d.*, and the cost of binding material about 3*d.* per square yard. With reference to the necessity of binding material, the following facts are interesting.

Mr. Wm. H. Grant, Superintending Engineer of the New York Central Park, in his report upon the park roads, says :† "At the commencement of the macadam roads, the experiment was tried of rolling and compacting the stone by a strict adherence to Macadam's theory, that of carefully excluding all dirt and foreign material from the stones, and trusting to the action of the roller and the travel of teams to accomplish the work of consolidation. The bottom layer of stone was sufficiently compacted in this way to form and retain, under the action of the rollers (after the compression had reached about its practical limit) an even and regular surface ; but the top layer, with the use of the heavy roller loaded to its greatest capacity, it was found impracticable to solidify and reduce to such a surface as would prevent the stones from loosening and being displaced by the action of waggon-wheels and horses' feet. No amount of rolling was sufficient to produce a thorough binding effect upon the stones or to cause such a mechanical union and adjustment of their sides and angles together, as to enable them mutually

* In Paris 3 to 3·75 ton-miles of roller are applied to every cubic yard of metal ; in America 5 ton-miles are thought necessary.

† *Vide* 'Roads, Streets, and Pavements,' by Q. A. Gillmore, p. 89.

to assist each other in resisting displacement. The rolling was persisted in with the roller adjusted to different weights up to the maximum load (12 tons) until it was apparent that the opposite effect from that intended was being produced. The stones became rounded by the excessive attrition they were subjected to, their more angular parts wearing away, and the weaker and smaller ones being crushed.

"The experiment was not pushed beyond this point. It was conclusively shown, that broken stones of the ordinary sizes, and of the very best quality for wear and durability, with the greatest care and attention to all the necessary conditions of rolling and compression, would not consolidate in the effectual manner required for the surface of a road while entirely isolated from and independent of other substances. The utmost efforts to compress and solidify them while in this condition after a certain limit had been reached, were unavailing." This has also been tried many times in England when an outcry against "binding" has been raised by some amateur road surveyors, but never with any success. Mr. Deacon tried the experiment in Liverpool, where with a 15-ton steam roller, after 27 hours continuous rolling, a trap rock macadam could not be consolidated; whereas when blinded with siliceous gravel from ¾ inch to the size of a pin's head, mixed with about one-fourth part of macadam sweepings, the whole area of 1200 yards was consolidated in nine hours.

From the foregoing it is very evident that some description of binding material is essential in making a road under a roller; but it should only be put on the road after the roller has been at work for some little time, and merely to bind the crust or skin of the road. Where traffic is allowed to consolidate a road it is different, as then the stones are knocked about and are sufficiently abraded against each other to form a binding material for themselves. Too much binding material or too much water should not be used in forming a road with a

steam roller. It is unfortunately frequently the case that a road is made quickly only to go to pieces with the traffic in a few weeks. The surface of a well-constructed macadamised roadway should after being rolled look almost like an encaustic pavement. If there is too much binding material in the joints of the stones, the first heavy rain washes it out and the surface of the roadway quickly goes to pieces.

The following description of the manner in which it is recommended that the roller should be applied is taken from an excellent little pamphlet on "Steam Road Rolling," by Messrs. Aveling and Porter, the well-known makers of steam rollers, and although local circumstances must guide the surveyor in all his works, the particulars may be of use:—

"In the best practice the roadway is excavated, graded, and properly formed to a depth of 14 inches from the level of the gutters, with a cross section conforming to the cross section of the road when finished; it is then thoroughly and repeatedly rolled with the steam roller, all depressions being carefully filled and rolled before the stone is put on. On the bed thus formed and consolidated a layer of stones 8 inches thick is set by hand, and rammed or settled to place by sledge hammers, all irregularities of surface being broken off and the interstices wedged with pieces of stone. The intermediate layer of broken stone, of a size not exceeding 3 inches in diameter, is then evenly spread to a depth of 4 inches and thoroughly rolled, and this is followed by rolling in half-an inch of sand. The surface layer of stone, broken to a size not larger than 2 inches diameter, and to a form as nearly cubical as possible, is then put on to a depth of 3 inches, thoroughly rolled, and followed as before by sand, also rolled. Finally, a binding composed of clean sharp sand is then applied, well watered and most thoroughly rolled with the steam roller, until the surface becomes firm, compact and smooth, the superfluous binding material being swept off and removed."

The following account of the method adopted in the United States at Hartford may also be of interest.*

"The surface of the road is excavated to a suitable depth —say, 18 inches; preparing the form for the pavement with the precautions as for a common pavement; 4 inches of gravel and proper drainage where required, provided blocks of stone of any irregular shape are selected for the pavement, of about 7 inches in thickness. The blocks are set by hand with great care, as closely in contact at their base as practicable. The surface between the blocks is filled with chippings of stone carefully laid in. A layer of broken stone, 4 inches thick, is laid over this pavement. The road-covering thus prepared should be rolled with the steam roller until the upper layer has become perfectly compact and consolidated. The second layer, about 3 inches in depth is then laid on; a coating of clean coarse gravel, 1½ inch thick, termed 'binding,' is spread over the surface, and the whole well rolled as before, and you have the requisites of a good road—viz., clean, hard, and even at all seasons. No road should be considered made until it is completely rolled. A road made in the manner above described, and kept perfectly clean, hard, and even, with materials of a good tough quality, would show extremely little wear on the surface; indeed, it has been found in France to be less than ½ an inch in a year, on a road of great traffic."

In the neighbourhood of New York the steam roller is used as follows:—

Two-and-a-half inches of trap rock is laid, and lightly rolled until the stones have become a little compacted, then coarse screenings are added, and it is again rolled; after this a layer of about 2 inches of stones are added and rolled with coarse screenings as before. Fine screenings or stone dust is then applied, and the roadway is then rolled until every interstice is filled up; it is then well watered and again rolled.

* *Vide* Aveling and Porter's pamphlet on 'Steam Road Rolling,' p. 32.

With reference to the employment of the steam roller in repairs of roads, the following description is given of the method adopted by the Surveyor to the Tottenham Local Board, near London.*

"When a road becomes so full of holes or so worn as to require coating throughout its entire length and width, it should be hacked completely over and raked into a segmental form in its transverse section to remove irregularities, and so that the road may have a fall from the crown to the channel of not less than one inch to a yard. It should then be coated with stone broken as nearly cubical as possible and to an uniform gauge. When spread it should be slightly coated with gravel screenings, or the grit sweepings from the roads, which are equally suitable for the purpose when in proper condition. The road should then be watered and rolled, beginning with the road at the channels, and ending at the crown of the road, until a smooth surface is obtained, more stones being added to fill up any inequalities that may exist, until the whole is consolidated. By constantly sweeping the grit from the sides to the crown of the road as the roller passes over, every stone is thoroughly grouted into its bed."

Another description is as follows :—

The stone is assumed to be granite, or some similar material. It is to be broken evenly so as to pass in every way through a ring two and a quarter inches in diameter.

The old surface of the road, if hard, is to be picked or stocked up in ruts six or eight inches apart across the road. If the surface be soft, less picking up will be required. All irregularities in the old surface are to be removed. The small materials derived from the old surface may be drawn off the road to be put back over the new coating.

The new materials are to be spread to a full thickness of three inches over the entire width of the road, and carefully formed to the proper cross section. Rolling is then to be

* *Vide* Aveling and Porter's pamphlet on 'Steam Road Rolling,' p. 33.

commenced, and is to be accompanied with watering by a water cart, unless the weather be wet; it is to begin at the sides and proceed gradually toward the middle of the road. Any hollows that may appear on the surface as the rolling proceeds are to be filled in with small material, the surface being slightly loosened if necessary. When the materials are thoroughly and closely wedged together, and present a mosaic-like surface (but not before), binding is to be added, to consist of fine clean gravel, coarse sand, the finest screenings from stone breaking (the latter being admirably adapted to the purpose), or clean road sweepings, as they may be most conveniently obtained. The binding is to be spread dry with a shovel, uniformly over the surface in small quantities, and is to be rolled into the interstices between the stones with the aid of watering and sweeping, fresh binding being added as that first applied works in. All the interstices between the stones at the surface of the road must be filled, and for this, if the stones be previously well consolidated by rolling, a quantity of binding not more than one-sixth or one-fifth of the bulk of the stones, equal to half an inch or a little more in depth over the entire surface for a three-inch coat, will be required. The closer the stones are consolidated, and the less binding that is employed to fill in the interstices, the better the road will be. The surplus binding should be swept off the surface.

Care must be taken not to soften the foundation of the road by excessive watering, especially in the earlier stages of the process. A greater length of road than can be thoroughly consolidated in one day should not be undertaken at once; that is to say, the rolling should be begun and finished in the same day. It is difficult to say how much rolling will be required, as it will depend on the nature of the material and of the binding, and other circumstances. It is not desirable, therefore, to begin with a larger area than 500 or 600 square yards, until experience has shown that a larger area may be thoroughly consolidated in a day.

After a coating laid with a steam roller has been exposed to the traffic for some time, hollows in the surface sometimes appear, even when the rolling has been apparently thoroughly done. Heavy loads on narrow wheels find out places which, from subsidence or some other cause, have escaped pressure of the roller. Such places should be picked up and filled with small materials, and, if necessary and convenient, be rolled. The surface, indeed, should never be neglected, but hollows, as they appear, should be patched in small pieces and with small stones, so as to keep a fair surface, free from puddles, to wear evenly until such time as the whole road again requires a coating.

Mr. R. Read, the Surveyor of Gloucester, says:* "The road should be thoroughly well lifted and the metalling spread in three-inch layers evenly, and rolled once or twice before the gravel or other binding material is spread; then spread gravel or sand evenly and well watered with fine distributor until the stone is entirely covered, and the sand does not adhere to the roller. Dam up the road channels to prevent water and sand running off into sewers, and let men scoop up the water, and throw it back on the road, as it collects in the gutters."

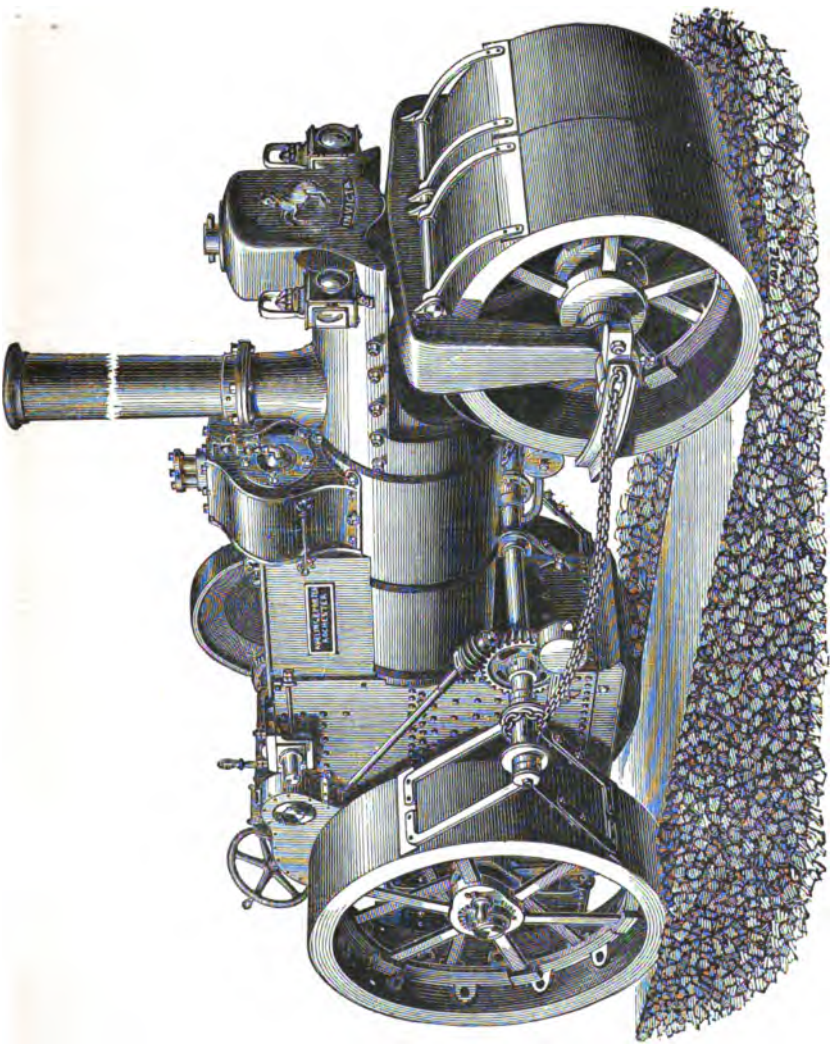
In all cases the sides should be rolled first to such a degree of firmness that when the roller passes over the centre or crown of road, its weight, which tends to spread the metal or make it work off towards the sides, may be resisted by their consolidation.

With reference to the effect of the weight of steam road-rollers upon roadways, it may be well here to compare that of a 15-ton roller with other burdens that a road has to bear, taking each case at per inch of width of tire.

An ordinary loaded two-wheeled cart presses with a weight of about 9 cwt. per inch width of tire, a loaded waggon about $7\frac{1}{2}$ cwt., a 9-ton traction engine about $3\frac{3}{4}$ cwt., and a

* *Vide* 'The Use of Steam Rollers,' by A. W. Parry, Reading.

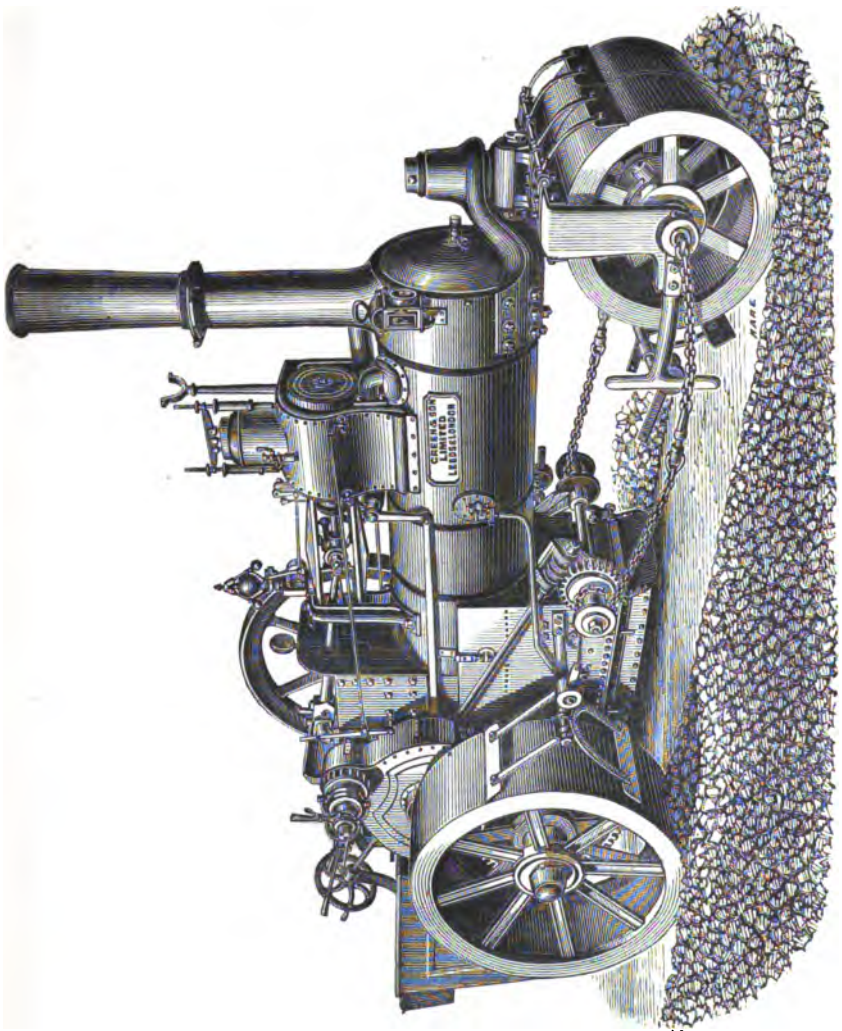
15-ton steam road-roller about 3½ cwt. So that as far as the surface of the roadway is concerned, a roller affects it the least of any of the above loads.



MESSRS. AVELING AND PORTER'S 15-TON STEAM ROAD-ROLLER.

It has, however, been found that where rollers of more

weight than 15 tons are used,* not only are they unwieldy, but, from their great weight, the solidity of the foundation of



MESSRS. GREEN AND SON'S 15-TON STEAM ROAD-ROLLER AND TRACTION ENGINE COMBINED.

the roadway may be interfered with, and also there is great

* Some road surveyors contend that for gravelled roads 6-ton rollers are heavy enough, for macadam roads 12-ton rollers.

danger of damaging gas or water mains and services, besides any cellars that may be constructed under the roadway.

The steam rollers which are principally used in this country are those manufactured by Messrs. Aveling and Porter, and those by Messrs. Green and Sons, drawings of both of which are represented.

In Paris the Gellerat steam roller is used, and another is also known, which is manufactured by Messrs. Morland and Sons.

A 15-ton steam roller costs about 650*l.* in the first place, the cost of working it, &c., has been given in the early pages of this chapter.

The advantages of steam road-rolling may be summed up as follows:—

(1.) The saving of wear and tear to vehicles and horses. Roads should be made *for* the traffic, and not *by* it.*

(2.) Economy; as it is said that a saving of from 30 to 50 per cent. is effected by reason of the roads being better made; thus obviating the necessity for such frequent sweeping and scraping.

(3.) The roads can be made or repaired at any season of the year.

(4.) The avoidance of cruelty to horses, cattle, and sheep, as in the case of newly-metalled unrolled roads.

(5.) A saving of road metal. (*a*) Because it need not be broken so small. (*b*) Because there are no loose stones to be kicked about and lost. (*c*) Because there is no abrasion of the stones, only one surface of the stone being exposed. (*d*) Because no ruts can be formed in which water can lie to rot the stone. (*e*) Because a thinner coating of metal can be employed.

(6.) The roller can be advantageously used for other purposes.

(7.) Rolled streets have a better appearance, they are

* Traffic in making a roadway is apt to grind off the sharp edges and spoil the metal before it is set.

easier of traffic as having more evenness of surface and superior hardness; and it is contended that if steam rollers were more general there would not be such an outcry for other descriptions of pavement for roadways.

(8.) The steam roller soon finds out the good from the bad metal for roads; it is also contended that it also does this with respect to the gas and water mains; the latter, however, may be looked upon as a rather doubtful advantage.

(9.) The avoidance of the necessity of the continued employment of men raking the metal into the ruts.

In Mr. Paget's valuable little pamphlet upon the subject of steam rolling * may be found the following remarks:—

"One of the main advantages attending the rolling of roads by steam-power, consists in the diminished proportion of mud or soluble matter which is then incorporated in the structure of the road surface. If the surface of an ordinary road that has not been rolled is broken up and the material washed, it is found that as much as half of it is soluble matter, mud, dirt, and very fine sand; the stones, having only been thrown loosely upon the road, have lain so long before becoming consolidated by the traffic, and have undergone in the meantime such extensive abrasion that the proportion of mud, dirt, and pulverised material in the metalling is increased to that extent, and the stones are really only stuck together by the mud. This accounts for the fact that although an unrolled macadamised road may indeed, after long use, have a surface that is pretty good and hard in dry weather, and may offer then a very slight resistance to traction, yet it will quickly become soft and muddy when there is any rain. By the employment, however, of a steam roller upon the newly-laid metalling of a macadamised road the stones are rolled in and well bedded at once, and the

* 'Report on the Economy of Road Maintenance and Horse Draught through Steam Rolling with special reference to the Metropolis,' by Frederick A. Paget, C.E., etc. etc., London, 1870, to which I refer my readers for many scientific and useful facts upon this subject.

surface is thus consolidated into a sort of stone felt, capable of resisting most effectually the action of ordinary traffic, and containing the smallest quantity of soluble matter to form mud in wet weather."

The following points in connection with this subject will be of use—

(1.) Rollers must not be too heavy, or otherwise they may injure the foundation of your road, or crush the stones of which it is made, or break gas or water-pipes, or even fall into a cellar, or break into a culvert. From 10 to 15 tons has been proved to be a good margin of weight.

(2.) Do not have the rollers too wide, or else they will press unevenly on the contour of your road.

(3.) Roll the haunches of the road always *before* you roll the centre.

(4.) Do not attempt to consolidate the metal without the use of "binding," such as gravel, sand, chippings, or road drift, and a certain quantity of water.

Having given the advantages of steam road rolling, I will now proceed to give the disadvantages.

(1.) The first cost; this to a small borough or town is often the great stumbling-block. It is a pity that two or three of them could not join, and procure one between them at joint cost, thus avoiding the individually heavy burden.

(2.) The risk of damage to gas and water mains and services; or even of cellars under the streets in some of the older towns.

(3.) The interference to traffic whilst the roller is at work; the result is generally unsatisfactory if, to avoid this, the machine is worked during the night.

(4.) The noise and smoke.

(5.) The risk of frightening horses.

(6.) If too heavy a roller is used, the foundation of the roadway may be injured or the metal may be crushed instead of bedded.

(7.) The necessity of using so much binding material and water.

Before closing this chapter it will be necessary to say a few words upon rollers drawn by horses.

These are always unsatisfactory: they are expensive to use, as a large team of horses and a number of attendants are necessary; they are difficult to turn, and the horses' feet displace almost as many stones as the roller compresses into their beds.

They cannot be of greater weight than 10 tons, even when on the hydrostatic principle, and they are clumsy and difficult of manipulation.

If a roller is to be used at all, let it be a steam road roller of the most modern description, and of the best manufacture.

CHAPTER VIII.

PITCHED PAVEMENTS.

IT has been asserted that where a roadway has a traffic exceeding 1000 vehicles per diem, that to maintain it as a macadamised roadway is not economical.* However that may be, it is unquestionable that for very heavy traffic blocks of hammer-dressed stone, laid upon a concrete or hard gravel bed, have been in use for a great number of years, and indeed the Romans, who were great road makers, introduced the system (the Archaic, as it is sometimes called) into this country more than 2000 years ago; the size of the paving stones was, however, much larger than modern science finds necessary.

There is no doubt that a roadway paved with syenite, granite, or whinstone setts, upon a hard concrete foundation, presents a most enduring pavement, costing but a few pence per annum in repairs and cleansing, and in other respects it answers nearly all the requirements of traffic except in two very important particulars—it becomes very greasy and slippery under certain conditions of the weather after having been laid any time, and it is an intolerable nuisance in any great thoroughfare, from the incessant din and clatter arising from the wheels of vehicles and the iron shoes of the horses

* In the year 1885 Mr. Clement Dunscombe, the then City Engineer of Liverpool, reported that there were a million and a quarter superficial yards of impervious paved streets in the City, and that upon these the maintenance charge was practically nothing. Since that date about a quarter of a million yards more have been laid with most beneficial results as regards maintenance, notwithstanding an enormous traffic of about 300,000 tons per yard per annum and upwards upon some of the streets in this City.

striking upon it; so great is the noise in some thoroughfares thus paved, that tradesmen are compelled to keep their doors and windows tightly closed in order that they may be able to conduct their business, and it is known to injuriously affect the nerves and health of persons who are obliged to live in the vicinity of such streets. It is a bad pavement too for horses to travel upon, the jar upon the legs of the unfortunate animals soon telling upon them.

Great improvements, however, have in recent years been introduced to correct these faults. The setts are now made very narrow, about 3 inches in width, or 4 setts to 14 inches including the joints: this gives a better foothold for the horse, the hoof having but a little way to slip before being arrested by a joint; the narrow joint also lessens the noise, and helps besides to prevent the edges of the stones becoming worn or the pavement wearing unevenly. It is also affirmed that laying the setts diagonally across the street greatly diminishes noise, and the tendency of the setts to wear round at their arrises.

Running the joints with an asphaltic composition instead of ordinary grouting has also materially conduced to deaden the noise.

Taking the question of cost into account—and cost of this description of paving, be it remembered, is considerably affected by weight, when carriage of the stone has to be considered—the following sizes of stones may be taken as satisfactory. *

Setts	.. ..	$6\frac{1}{2}$" × $3\frac{1}{2}$" × 5" to 7" long	
,,	.. ..	$7\frac{1}{2}$ × $3\frac{1}{2}$ × 5 to 7	,,
Cubes	.. ..	$3\frac{3}{4}$ × $3\frac{3}{4}$ × $3\frac{3}{4}$	
,,	.. ..	4 × 4 × 4	
Blocks	.. ..	4 × 4 × 6 deep	
,,	.. ..	$3\frac{1}{2}$ × $3\frac{1}{2}$ × $6\frac{1}{2}$	,,

* In Paris, after considerable research into the question, the engineers of the Ponts et Chausées decided that the size of the paving stones, which used formerly to be 9 inches square, should be 4 inches wide by $6\frac{1}{2}$ inches long by $6\frac{1}{2}$ inches deep, the stone that is used being a grit sandstone, from the forest of Fontainebleu.

The following table, showing the number of square yards that 1 ton in weight of different sizes of granite setts, cubes, or blocks will cover, may be of use, but this must vary with the specific gravity of the stone employed.

	Depth.	Width.	Length.					
Setts	5	× 3 ×	5 to 7 inches	1 ton will pave	4·5	superficial yards		
,, ...	5½	× 3½	,,	,,	,,	4·3	,,	,,
,, ...	6½	× 3½	,,	,,	,,	3·6	,,	,,
,, ...	7½	× 3½	,,	,,	,,	3·1	,,	,,
Cubes	3½	× 3½ × 3½	,,	,,	,,	6·7	,,	,,
,, ...	3½	× 3½ × 3½	,,	,,	,,	6·2	,,	,,
,, ...	3⅝	× 3⅝ × 3⅝	,,	,,	,,	5·8	,,	,,
,, ...	4	× 4 × 4	,,	,,	,,	5·4	,,	,,
Blocks ..	4	× 4 × 6	,,	,,	,,	3·6	,,	,,
,, ..	4	× 3 × 3	,,	,,	,,	5·4	,,	,,
,, ..	5	× 3 × 3	,,	,,	,,	4·4	,,	,,
,, ..	6	× 3 × 3	,,	,,	,,	3·7	,,	,,
,, ..	6½	× 3½ × 3½	,,	,,	,,	3·25	,,	,,

The question of the best class of stones to employ as a paving material must to a great measure depend upon local circumstances, but it is important to select such stones as are very hard and durable, but which will not wear smooth and slippery nor round by reason of the chipping off of their edges.

Nearly all granites are suitable for this work, but Carnarvonshire syenite * is said to be the best material that can be used, although, being denser than granite, it is heavier and consequently more expensive.

At one time large quantities of paving stones were used in London and Liverpool which were brought from Bombay and China, as ballast for ships trading between those ports.

Mount Sorrel from Leicestershire and the Welsh stones have been accused of wearing slippery, as well as porphyry,

* Syenite is a hard, greenish-grey metamorphic rock, composed principally of silica, alumina, and lime, in conjunction with magnesia, iron, etc. Its specific gravity is 2·96.

whereas the presence of felspar in the granite always keep it rough under traffic.* Experience has, however, proved that in Liverpool, under the unusually heavy traffic to which some of the paved streets are subjected, the Welsh syenites are the most suitable for the purpose.

Of the granites, that from Dalbeattie in Scotland is said to be the best.

The following table, prepared by Mr. Walker in 1831, showing the wear of different stones, may be of interest.

TABLE SHOWING THE RESULT OF EXPERIMENTS MADE BY MR. WALKER ON THE WEAR OF STONES IN 1830–31 A PERIOD OF 17 MONTHS.

Name of Stone.	Superficial area in feet.	Original weight.	Loss of weight by wear.	Loss per superficial foot.	Relative losses.
		cwt. qrs. lbs.			
Guernsey	4·734	7 1 12·75	4·50	0·951	1·000
Herm	5·250	7 3 24·25	5·50	1·048	1·102
Budle	6·336	9 0 15·75	7·75	1·223	1·286
Peterhead (blue) ..	3·484	4 1 7·50	6·25	1·795	1·887
Heytor	4·313	6 0 15·25	8·25	1·915	2·014
Aberdeen (red) ..	5·375	7 2 11·50	11·50	2·139	2·249
Dartmoor	4·500	6 2 25·0	12·50	2·778	2·921
Aberdeen (blue) ..	4·823	6 2 16·0	14·75	3·058	3·216

The Aberdeen granite as at present laid in the City of London, 3 inches wide by 9 inches in depth, has a life of about 15 years.† In the City of Durham whinstone setts of the same width last 17 or 18 years; in Manchester similar granite setts last 15 to 20 years. On this subject Mr. Deacon, the then City Engineer of Liverpool, has collected some most valuable information, and I refer my readers to a paper read by him before the Institution of Civil Engineers in

* Mr. Boyle, District Surveyor of Manchester, says: "I would caution you against the use of the old blue Penmaenmawr stone as being an extremely slippery stone, and one which makes a dangerous pavement." *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers,' vol. iii. p. 58.

† The old granite paving of London used only to last eight years. *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. ix. p. 222.

1879,* for a great deal of useful information on this and other subjects connected with roadways.

Various methods have been adopted for constructing granite paved streets, some of which I will proceed to describe.

One of the first really good granite pavements introduced into London was that known as the "Euston Pavement," and it was constructed in the following manner: The foundation was shaped to the intended surface of the finished roadway; upon this a layer of coarse gravel was spread 4 inches in thickness; this was well rammed,† and upon it was spread 4 inches of gravel mixed with a small quantity of chalk to bind it; this again being well rammed, upon it was placed a similar layer only composed of finer gravel, and upon this foundation the stones were placed, being bedded upon about an inch of fine sand. The stones used were Mount Sorrel granite, which were hammer-dressed and squared 3 inches in width by 4 inches in depth; they were set close together at right angles with the lines of the kerb, they were then thoroughly rammed by the pavior. The whole surface was afterwards covered with screened gravel, which was allowed to find its way into the joints and thus steady the entire pavement.

In many cases the foundation is simply formed by shaping the soil to the required contour, and covering this with 3 or 4 inches of gravel or cinders, which is afterwards either rammed or consolidated by the traffic; upon this the setts are placed as closely as possible, the joints are then filled with fine gravel well worked in with a "cramming iron," the whole surface being then covered with a grouting

* *Vide* 'Street Carriageway Pavements,' by George Frederick Deacon, M. Inst. C.E., 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 1 *et seq.*

† The pavior's rammer is about 55 lbs. in weight, with an iron ring at its foot; this is swung with some dexterity between the legs, and is allowed to fall with great force upon the earth or stones it is in use upon.

of lime and sand, which is brushed into the joints with a stumpy broom.*

In Leeds, Manchester, Salford, and many other important cities, I believe the foundations are formed in the manner just described, but of greater depth, the grouting also

* The usual specifications for the Guidet paving blocks (in New York) require that they shall be of granite, equal in hardness to the Quincy granite, of durable and uniform quality, each measuring not less than 3½ nor more than 4½ inches in width on the upper surface or face, and not less than 10 nor more than 15 inches in length, and not less than 8 nor more than 9 inches in depth. Blocks of 3½ inches in width on the face to be not less than 3 inches in width at the base; all other blocks to measure on the base not more than 1 inch less in width or in length than on the face. The blocks are set upright in close contact on their edges in courses, with the longest dimensions and the continuous joints running across the street, breaking joints lengthwise of the street.

The ends of the blocks are dressed off so as to give close joints in the direction of the draught, while the broad vertical sides of the blocks are left ragged or uneven, or with the split rock-face, so that the continuous joints running across the street are somewhat open. *Vide* 'Roads, Streets, and Pavements,' by Q. A. Gillmore, p. 157.

The following specifications of the manner in which this work is carried out in America will be of interest.

Upon the road bed properly formed and compacted shall be spread a layer of clean, broken limestone, entirely free from dust, dirt, or other foreign substance, not less than 6 inches in depth, after being thoroughly rolled. Said stone shall be practically uniform in quality, of angular fragments, having rough faces obtained by fracture and measuring not more than 2½ inches in their largest dimensions, nor less than one inch in about equal proportions. Upon this a bed of limestone screenings or of fine, clean, bank gravel, containing no pebbles of larger dimensions than 1½ inch, shall be spread in such quantity that when thoroughly flooded it shall completely fill the interstices of the stone and leave besides 1 inch in depth over the whole surface of the stone, after rolling.

The stone and gravel shall be flooded with water and thoroughly rolled with a steam roller weighing not less than 15 tons, until the entire mass is brought to a true and uniform surface and thoroughly compacted to the satisfaction of the Commissioner of Public Works or his representative. Stone and gravel together to have a thickness of not less than 7 inches after having been thoroughly rolled, and the surface thereof to be from 8 to 9 inches below the top of the finished pavement. Over this shall be evenly spread a bed of clean, fine, sharp sand, thoroughly dry, not less than 2 inches nor more than 3 inches in thickness, to serve as a bed for the granite blocks, which shall be laid directly upon and imbedded in it.

The pavement to consist of syenite or granite blocks or stone, equal in quality to standard samples in the office of the Commissioner of Public Works, of a uniform grain and texture, without lamination or stratification, and free from excess of mica or felspar.

It is expressly understood that granite wearing roughly, and therefore affording better foothold for horses, will be considered preferable to the hardest.

is a bituminous mixture, which I will presently describe, instead of the ordinary lime grouting.

Where the traffic is heavy, however, a very firm foundation is necessary, and up to the present time no better foundation has been introduced than that of good Portland cement concrete. This should be at least 9 inches in thickness, and

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Hard basaltic stone, which will take a smooth polish under traffic, shall not be used. Soft or weatherworn stones, obtained from the surface of the quarry, will not be accepted. The stone blocks must be so quarried or dressed as to present substantially rectangular faces, with practically straight edges on top, bottom and sides; and all blocks whose faces vary more than ½ inch from a rectangular shape will be rejected. The sides and ends of the blocks must also be so quarried or dressed that they will make close-fitting joints. Blocks having projections or knobs larger than ½ inch will be rejected, unless so dressed that said projection or knobs will be within the limits prescribed. The dimensions of the stone will be from 3½ to 4½ inches wide, 6 to 7 inches deep, and not less than 6 nor more than 10 inches long. Each stone shall have even top and bottom beds.

The blocks will be carefully inspected after they are brought on the line of the work, and all blocks or other material, which in quality or dimensions do not strictly conform to these specifications, or which may be otherwise defective, shall be rejected, and must be immediately removed from the line of the work by the contractor. The contractor will be required to furnish such labours as may be necessary to aid the inspector in the examination and culling of the stone and other material, and in case the contractor shall neglect or refuse so to do, such labourers as in the opinion of the Commissioner of Public Works may be necessary, will be employed, and the expense incurred shall be deducted from any money then due, or which may thereafter become due to the contractor.

The blocks must be laid in uniform courses across the street, and spaces between the sides or ends of the blocks, when in place, shall in no case be less than ½ inch nor exceed ⅝ inch. The stone blocks shall be so laid as to break joints in alternate courses, each course as far as practicable to be of uniform depth and width, and so laid that all longitudinal joints shall be broken by a lap of at least 2½ inches.

When thus laid the pavement shall immediately be covered with clean, screened, dry (roofing) gravel, free from sand or loam, or pebbles smaller than ⅛ inch, or larger than ½ inch in size, in proper quantities and raked until all the joints become filled therewith, and the blocks then rammed with a 75-pound rammer, the point of which shall be 3½ inches in diameter, by competent and experienced workmen to a firm, unyielding bed and uniform surface to proper grade. In the above described ramming each stone shall be struck two full blows; a lighter rammer shall then be used to bring the pavement to a perfectly uniform surface.

A space of ⅝ inch will be left between the top of the gravel in the interstices and the top of the pavement, which will be filled full with a hot asphaltic mixture. This mixture must be poured into the joints of the blocks at a temperature of 300° Fahrenheit, until the sand beneath and the gravel between them will absorb no more and the joints are filled flush with the upper surface

be composed of one part of Portland cement, two parts of clean sharp river sand, and four parts of clean river ballast, or broken stones, or other suitable material. The surface of the concrete, after having been placed in position, should be smoothed over with the shovel, so as to present the proper convexity and have an even surface for the granite setts to be bedded on.

In Liverpool the foundation is formed as follows: a Portland cement concrete foundation is laid six inches in thickness. The concrete consists of one part by measure of cement, five to six parts gravel, and seven to eight parts broken stone. The gravel and cement being thoroughly mixed dry, and only enough water then allowed to flow on it to make the material damp enough after it is incorporated to retain its form when a portion is taken in the hand and squeezed.

The ground having been excavated, thoroughly consolidated and properly graded to the requisite shape, a layer of broken stone, or other material, is spread evenly over the

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of the payment. In no case shall be used for this purpose less than 2½ gallons per square yard of paving.

Said asphaltic mixture shall be composed of coal tar, pitch made from coal tar, gas tar and creosote oil, in the proportions of 1 cwt. of pitch to 4 gallons of tar and 1 gallon of creosote, proportions which are varied somewhat according to the quality of the pitch used. The materials composing the mixture must be melted together and boiled for from 1 to 2 hours in a boiler adapted to the purpose, and must be tempered to the satisfaction of the engineer in charge before it is poured into the joints; and any of the cement which does not flow freely at the proper temperature shall be rejected and removed from the work.

Another paving cement may be obtained from direct distillation of coal tar, and of the consistency ordinarily numbered between 5 and 6 at the manufactory.

The Commissioner of Public Works reserves the right to decide which of two named compositions shall be used.

The object of asphaltic jointing is to make the paving impervious to moisture; to create a bond with a degree of elasticity sufficient to prevent it from cracking, and to prevent formation of mud, thereby facilitating the cleaning of the pavement.

It is therefore expressly understood, that the Commissioner of Public Works will permit only the very best asphaltic mixture known to be used for the above purpose.

After the aforesaid treatment the entire surface of the street shall be covered with a light coating of dry fine gravel, containing no pebbles larger than ¾ inch, for the purpose of consolidating the same with the asphaltic jointing.

surface and thoroughly wetted from the rose of a watering can. A stratum of concrete, mixed as above, is spread over this and a second layer of stone added. The stone is then beaten in with a heavy flat beater. Other layers of mortar and stones are added and thoroughly beaten in until the required thickness is obtained, the final layer of cement concrete being smoothed off to an even and uniform surface. After this concrete or bêton foundation has been allowed to set ten days the paving is commenced.

The setts are laid upon a bed of fine gravel about half an inch in thickness in regular, straight, and properly bonded courses with close joints. The joints are then filled with hard clean dry shingle, the whole is then thoroughly rammed, more shingle being added till the joints are full. The joints are then carefully filled with a hot mixture of coal-pitch and creosote oil, and the pavement covered with half an inch of sharp clean gravel.

Another description of foundation now very extensively used where the traffic is not so heavy, is that known as "Bituminous Concrete," which is made as follows.

The ground being excavated to the proper depth and contour, broken stone as for macadam is spread for a depth of 6 or 9 inches; this is then levelled and thoroughly rolled with a light roller, a boiling mixture of pitch and tar, or creosote oil is then poured over the whole surface until every interstice is filled, when a thin layer of small broken stone is spread upon it, and then well rolled until it consolidates.*

* The cost per square yard of bituminous concrete foundation in Liverpool, 6 inches deep, is as follows:—

	s.	*d.*
0·153 ton broken stones, including cartage 6*s.*	0	11
0·041 ton pitch, 30*s.*	1	3
1·2 gallon oil, 2½*d.*	0	3
0·007 ton coke, 12*s.*	0	1
Labour	0	9
	3	3
Add for establishment expenses 8 per cent. ..	0	3
	3	6

It may be well to observe here that in all works involving concrete foundations and paving in streets, the traffic should be entirely stopped if at all possible. Streets paved half at a time are never quite satisfactory, and the concrete should have at least a week to set before the pavement is placed upon it.

Upon a foundation of either Portland cement or bituminous concrete, the granite setts themselves should be grouted with a bituminous mixture instead of cement or lime grouting. This renders the pavement more impervious to moisture, makes it less noisy, and adds considerably to its strength; the mode of applying it is nearly similar to that of ordinary grouting. The setts are placed on about an inch of sand and well rammed, the boiling mixture is then poured over the whole surface, which is then covered with a thin coating of small, sharp gravel.

The following table of the proportions necessary for the bituminous mixture may here be of use.

PROPORTIONS FOR BITUMINOUS MIXTURE.*

	Pitch.	Tar.	Pitch.	Cresote oil.
For grouting in pavements	1 to	1 or	3 to	1
For foundations or lower layer of asphalte macadam	3 to	1 or	3½ to	½
For upper layer of asphalte macadam and for foot paths	2½ to	1½ or	3½ to	¾

The objections to this method of paving are only temporary: the nuisance arising from the fumes of the boiling mixture whilst it is being applied, and the necessity for dry weather to make the operation successful. Healey's Patent Pitch Boilers† are said to moderate, if not entirely to do away

* As these ingredients often vary very much in their constitution, the surveyor must use his judgment to a great extent as to these proportions.

† The boilers are now much used for such purposes, they hold from 60 to 500 gallons and are light and portable; the temper of the bituminous mixture also remains uniform whilst being drawn off, and there is very little evaporation or waste arising from them.

with the former, and the latter can be arranged by only doing the work at favourable seasons.

Before closing this chapter attention may be drawn to a recent method of Pitched Pavement Construction introduced by Mr. Donald Nicoll, C.E., which may be described as follows.

Twelve three inch granite cubes are swathed in a composition of plastic bitumen and cocoanut fibre, and then massed by compression into blocks measuring fourteen inches by twelve inches. These blocks or sections are laid upon the usual concrete bed and jointed together by heat. Between the blocks and the concrete a layer or pad, nearly an inch in thickness of the bituminous fibre compound is laid, by which it is contended the effect of percussion, and noise is reduced to a minimum.

CHAPTER IX.

WOOD PAVING.

In the year 1843 Mr. Charles Cochrane, the President of the "Association for the promotion of Improved Street Paving, etc.," in a paper which he read before the Institution of Civil Engineers, on the State of the Streets of the Metropolis, said that there existed at that date 100,000 yards of wood pavement.* He further states that it is said to be slippery, but that he approves of it as the best material hitherto used, "both as regards its general economy and durability as well as its facility of traction, and more especially its extreme cleanliness."

Two years previous to this date, Mr. Edward Lomas condemned wood pavement as slippery, and recommended granite pavement for horses with wood tram-tracks for the wheels of vehicles.†

Since these dates the question of wood paving has made giant strides, many companies and private firms having started business as wood paviors, with many various methods, which they strongly advocate as being superior to the others; amongst them I will enumerate and describe the following:

The Improved Wood Pavement Company.—The ground being consolidated, a layer of sand is made the basis of the pavement, and assumes the shape the surface of the street

* The first wood pavement laid in London was in front of the Old Bailey, in 1839.

† *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. i. p. 131.

is intended to take. Red-wood boards 1-inch in thickness are then laid across the roadway, from kerb to kerb, placed together so as to break joint; boards of the same material and thickness are then laid longitudinally, and breaking joint in the same manner. On this foundation red-wood blocks are placed in rows, taking the same direction as the under flooring.

Between each row of blocks, a strip of wood $\frac{3}{4} \times \frac{3}{4}$ inch is nailed to the block and flooring, the blocks in all cases breaking joint; the spaces thus formed between the rows of blocks are then run with a thick composition which fills all vacant spaces there may be between the strip and the block, covering the strip about $\frac{1}{8}$ of an inch. Gravel, dried and sifted through $\frac{3}{4}$ inch mesh, is then put in, solidly rammed and composition poured in; the pavement is then covered to a depth of $\frac{1}{4}$ an inch with dried gravel and composition for the purpose of indurating the surface, and filling the spaces flush with the top of the block; a slight covering of sand is then spread, when the traffic may immediately pass over. This specification is the company's own, as advertised when they first began business; for many reasons the boards have since been discontinued, and other alterations introduced into the system.

The Asphaltic Wood Pavement Company.—After the ground is properly prepared, 6 or 9 inches of concrete is laid, on this is laid a bed of asphalte not less than $\frac{1}{2}$ inch in thickness; then wood blocks 3 by 8 by 5 inches, or 3 by 9 by 5 inches, of good, sound, yellow Baltic timber are laid with joints $\frac{1}{8}$ inch in width; these joints are filled from 2 inches up with heated asphalte, the remaining 3 inches being filled with a grouting of hydraulic lime, and clean, sharp, fine river grit or sand, the whole being covered with a top dressing of fine, sharp sand, which wears in with the traffic.

Croskey's Wood Pavement.—Upon a bed of concrete, cross grained planks were to be placed side by side and be forced

together by pressure so as to form a compact homogeneous surface of wood.*

Lloyd's Patent Keyed Wood Pavement.—The special feature of this system is that *Pitch Pine* blocks are used laid *direct* upon the concrete foundation, the blocks being grooved on each side so that the grouting (composed of Portland cement) shall run in and form a key.

Harrison's Wood Pavement.—This system consists of a concrete foundation, upon which strips of wood 2 inches wide by $\frac{1}{2}$ an inch in thickness are laid. Upon these, wood blocks 3 inches in breadth are placed, and then hot asphalte is poured into the joints, which conglomerates the whole.

Henson's Wood Pavement.—The main feature of this patent consists in placing common felt on the concrete bed, and between the joints of the wood blocks; thus, it is contended, giving elasticity and allowing for the expansion and contraction of the blocks. The blocks are also bevelled on the top and grooved in a particular manner.

Carey's Wood Pavement.—In this case the blocks are cut 4 inches wide by 9 inches long, and 5 or 6 inches deep, according to the traffic; these blocks are shaped with alternate convex and concave ends, and are laid on a bed of sand about 2 inches thick, the joints between the blocks, which have been left about $\frac{3}{8}$ inch wide, being filled with a grouting of lime and sand.

Messrs. Mowlem and Company's method of laying wood paving is to form a foundation of concrete, varying in thickness according to the nature of the subsoil and the traffic; then to pavé with blocks of yellow deal, 3 inches wide and 6 or 7 inches deep; the joints, which vary from $\frac{3}{8}$ to $\frac{1}{2}$ inch, are filled in with sand and lias lime, and the surface is afterwards indurated by strewing it with shingle.

Patent Ligno-Mineral Paving Company.—This company lays claim to the speciality of using hard woods as well as

* I am unable to ascertain if this plan has ever been tried anywhere.

pine, and that the pine blocks they employ are preserved or mineralised so as to be more durable than the wood in its natural state.*

Nicholson's Wood Pavement.—This is principally in use in the United States, and consists of rectangular blocks of pine laid upon a close flooring of pine boards, 1 inch thick, laid lengthwise with the line of street, their ends resting on similar boards laid transversely from kerb to kerb, the boards being thoroughly tarred and laid upon a bed of sand. The joints of the wood blocks are run with an asphaltic mixture, and the whole surface is finally covered with hot coal tar and sprinkled with fine sand and gravel.

Stowe's Wood Pavement.—This is also American, the blocks resting directly upon sand or gravel about 6 inches in thickness.† "The blocks are set in courses transversely across the street, so as to break joint lengthwise of the street, the courses being separated from each other 1 inch by a continuous course of wooden wedges placed close together edge to edge, and extending from kerb to kerb. These wedges are set in the first instance with their tops flush with the top surface of the blocks. After the whole pavement shall have been well rammed, so as to give each block a firm bed, the wedges are driven down about 3 inches, and the open joints thus formed above them between the courses are filled in with a concrete composed of hot coal tar and fine roofing sand and gravel. The surface of the pavement may then be coated with coal tar prepared by boiling with pitch, and finished off with a thin layer of sand."

Wood Paving in Norwich.—Mr. P. Marshall, the City Surveyor of Norwich, states ‡ that the wood pavement in that

* It is also affirmed by the Borough Surveyor of Sunderland that this process dispenses with watering. *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. iii. p. 72.

† *Vide* 'A Practical Treatise on Roads, Streets, and Pavements,' by Q. A. Gillmore, p. 166, which see also for a good account of wood pavements in the United States.

‡ *Vide* 'Wood Pavements,' by Henry Allnut, 1880, p. 22.

city is "simply laid on the road formation levelled up with shingle. The blocks are grouted in with blue lias lime and well rammed down. This makes a splendid road, and is superior to any portion of the road that has been laid with concrete. This wood paving, 5 inches deep, laid as described, costs *7s.* per yard super. We have had some down here now for 2 years, and have had no settlement whatever. It is a very important matter, for it makes wood paving possible for country towns."

Shiels Composite Block Paving.—This pavement consists of composite blocks 12 inches by 15 inches, cast in iron moulds, with two rows of wood placed at an equal distance from either side and each other, the vacant spaces being filled with granite broken as for macadam; over all is poured a boiling composition of pitch, chalk, and sand. The blocks are thus treated at the works, and are, when cool, taken to the street, laid on a concrete foundation, and grouted with cement grouting.

Prosser's Wood Pavement.—This is composed of blocks sawn at an angle of 60°, the grain of the wood running in the same direction. Each end of the block rests on the other, transversely to line of street. Between the rows of blocks a plank, the same depth as the blocks, but with the grain of the wood horizontal, is placed. The blocks, which on one side of the plank lean in an opposite direction to those on the other, are secured or dowelled together by wooden pins running through the plank and piercing the blocks about an inch.

Elli Wood Paving.—The following is the printed description of this pavement: "Excavate the ground 11 inches deep, then [illegible] or 7 inches [illegible]ones or gravel 6 inches deep, well ramming same filled in with sai[illegible] proper camber of the street, with a layer of indurated by strew[illegible]on top, then place the Oak Pegs, which

Patent Ligno-Min[illegible] 2 to 4 inches in diameter, fill up lays claim to the speciality [illegible]mall quantity of water, well ram

* I am unable to ascertain if this pla[illegible]

same, sand again and ram until an even and solid surface is produced.

The advantages claimed for this paving are as follows :—

Firstly, The price, viz. about *7s.* per square yard, is less than the ordinary Wood Block Paving, and the Pegs will be of home production.

Secondly, For the repairs or laying down of Sewers, Water or Gas Pipes, etc., it is much more easily taken up and replaced, as there is no bed of Concrete to break through and make good.

Thirdly, The durability of the Oak Pegs is at least twice that of the ordinary Wood Block Paving.

Fourthly, This Paving has a better foothold for horses especially when the streets are on a gradient.

Lastly, The time taken in paving a street will be considerably less, as there is no Concrete used, hence the Paving can be proceeded with the second day after breaking open the street."

It is stated that the Paving has been laid down for about four years in Rome, Milan, Florence, Geneva, Bologna, and other Italian cities, increasing always in extension. It was laid down at Nice last year, and in Paris some six months ago, it has also been laid down at Brussels, Barcelona, and several other Continental Cities, and in each instance has given general satisfaction. Some trial pieces laid down at Bristol are said to be giving satisfaction.

Jarrah Wood Paving.—In Westminster Bridge Road and some other localities this wood, which is imported from Australia, has been used with considerable success. The price has, however, for many reasons become so great that it is almost impossible to use this wood largely, though it seems to be most suitable for the purpose.

In Chicago, U.S.A., cedar blocks 6 inches square, set on a composition of tar and gravel, are used, and are said to make a very durable pavement.

The following sanitary objections to wood as a material for pavements are made in the Report on the Application of Science and Art to Street Paving and Street Cleansing of the Metropolis (1872), page 17.

"The General Board of Health set aside wood as an ineligible material for this amongst other reasons, that street surfaces ought to be impermeable; and for roads of light traffic and cheap construction, they looked to modifications of macadam, with bituminous binders of mineral tar. Since then wood has been reproduced for the purpose, and strongly pressed in improved forms for trial. It certainly offers the advantage of a great gain in noiselessness over granite, more especially from the horses' feet, though with some disadvantage from a dead rumble and vibration; and further it has the advantage of being more available than smooth pavements for inclines. But hygienists object to its use on grounds, which, in the absence of sanitary science, are overlooked, but which it is important to particularise as showing the dangerous state of ignorance and incompetency of the authorities by whom they are not entertained, or are disregarded."

The sum total of the charges against wood as a pavement consists in the following: "Wood is porous, it is composed of bundles of fibres, it absorbs and retains wet, foul wet especially." Why *foul* wet should be absorbed more than ordinary wet does not transpire.

There is no doubt that wood in its natural state does absorb a large quantity of water,* but this can be avoided in wood paving by preserving the wood of which it is composed by one of the following processes:—

(1) Burnetising .. .. Chloride of zinc is used in this process.
(2) Kyanising .. .. Corrosive sublimate is used.
(3) Renwickising .. Boiling in coal tar.

* The power of absorbing water by wood varies from 9·37 to 174·86 per cent. in dry wood. In its ordinary state the power varies from 4·36 to 150·64 per cent. The quantity of water contained in wood in its natural state varies from 4·61 to 13·56 per cent. *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lvi. p. 300.

(4) Boucherising .. .. Sulphate of copper is used.
(5) Bethelising .. .. Creosote heated to 200° F. is used.
(6) Seelyising .. .. Creosote is also used, the wood being first boiled.
(7) Hayfordising .. .. Creosote is also used, wood being unseasoned.

The fibres of the wood are also compressed, and no open joints between the blocks are permitted, by paving the blocks transversely, with butt joints closely packed together, and by filling the cross joints with an asphaltic or other impervious grouting.

Wood paving should, however, be laid in streets with moderate traffic, and plenty of sun and air. In confined spaces such as courts, it soon rots and becomes a source of much unhealthiness.*

Many reports have been from time to time made on the advantages and disadvantages of wood paving, and much has been said and written upon the subject, so that I will only touch upon some of the principal questions at issue.

The first of importance is that of durability, and although the life of a hard wood constantly exposed to attrition is amazing, as may be seen on the stairs of the Metropolitan Railway Stations, and in many cog wheels of old machinery, still some diversity of opinion exists as to what may be fairly put down as the wear per annum of the surface of a street paved with wood blocks.

It must be remembered that to arrive at any fixed ratio of wear, a standard of traffic should be fixed; but this unfortunately has not hitherto been done, so that the results of observations are bound to differ considerably. The best classification of this kind has been prepared by Mr. G. H. Stayton in a paper he read before the Institution of Civil Engineers,† in which he gives the cost of maintenance as follows:

* *Vide* 'Roads and Roadways,' by George Waller Willcocks, 1879, p. 34.

† *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. xxviii. part iv. p. 280.

COMPARATIVE WEAR OF WOOD PAVEMENTS AS REDUCED TO A TRAFFIC STANDARD.

Situation.	System.	Weight per yard, width per day of 16 hours.	Depth of annual wear of wood.	Comparative annual wear of wood as reduced to a traffic standard of 750 tons per yard width per diem.
		Tons.	Inch.	Inch.
Fleet Street . .	Asphaltic . . .	1,360	0·456	0·251
Ludgate Hill .	Improved . . .	1,236	0·428	0·259
Oxford Street .	Henson's (E. section)	1,191	0·191	0·120
Fleet Street . .	,, . . .	1,165	0·269	0·173
Oxford Street .	Plain	1,164	0·475	0·306
,, ,, .	Asphaltic . . .	1,137	0·484	0·319
Parliament Street	Improved . . .	1,106	0·154	0·104
Leadenhall Street	Henson's. . . .	1,000	0·264	0·198
Oxford Street .	,, (W. section)	985	0·329	0·250
,, ,, .	,, (Central) .	948	0·323	0·255
Leadenhall Street	Improved . . .	808	0·200	0·186
Brompton Road.	Asphaltic . . .	648	0·373	0·431
King's Road. .	Improved . . .	603	0·157	0·195
Brompton Road.	Henson's. . . .	584	0·184	0·236
Edgware Road .	Plain	584	0·198	0·254
Regent Street .	Asphaltic. . . .	558	0·286	0·384
,, ,, .	Lloyd's	558	0·214	0·288
King's Road. .	Improved (pitch pine)	558	0·089	0·119
,, ,, . .	Plain	551	0·144	0·196
,, ,, . .	Plain (asphalte bed)	498	0·139	0·209
,, ,, . .	Plain (pitch pine) .	468	0·055	0·088
,, ,, . .	Creosoted blocks (mastic joints)	434	0·139	0·240
,, ,, . .	Creosoted blocks (lime joints)	407	0·111	0·204
Sloane Street .	Plain	279	0·065	0·175

It must not be lost sight of that the reason of excessive wear in a wood pavement often arises from wide joints being the means of causing the edges of the blocks to abrade and become worn.

Mr. D. T. Hope, in a paper he laid before the Scottish Society of Arts, upon some most careful investigations he had made on this subject, gives the wear as $\frac{1}{8}$ of an inch in 18 months on blocks laid with vertical fibre, which he proved was the best manner of laying them to ensure the longest life.

Mr. Deacon estimated the wear at from $1\frac{3}{8}$ inch to $2\frac{5}{16}$ inches per annum.*

Vide 'Minutes of the Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 82.

Mr. Copland estimated the wear at $\frac{3}{16}$ of an inch per annum.*

Mr. Howorth estimates the life of wood paving at 25 years per inch of wood, if an absolutely uniform quality of wood fibre could be assumed.†

Mr. Haywood says,‡ "Wood pavements with repairs have in this City (London) had a life varying from 6 to 19 years, and that with repairs an average life of about 10 years may be obtained."

The life of wood is no doubt extended by being preserved by one of the processes I have enumerated, but as its life may be taken as a average of 8 to 10 years, and as the blocks are bound to wear unevenly, they should be made as shallow as is consistent with stability; as it is an undisputed fact that the foundation of a roadway is the important carrier of the traffic, the surface material, of whatever it may be constructed, only acting as a skin to preserve it. If the blocks are too thick unnecessary capital is locked up.

Wood pavement was laid in Sunderland§ in 1859 with strips of creosoted red pine, creosoted beech wood, and unpreserved oak, the bulk of the paving being unpreserved red deal, and this was replaced in 1867.

In 1877, on renewing the pavement, it was found that the creosoted wood suffered less from wear and tear than the unpreserved, so the whole was done with creosoted red pine; the original strip of creosoted red pine was left untouched, the strip of oak was turned, and the beech was merely raised; and there is no doubt that the best wood pavement is that which can be constructed in the simplest manner, as for instance

* *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lx. p. 293.

† *Ibid.* vol. lviii. p. 45.

‡ 'Report upon Asphalte and Wood Pavements,' by William Haywood (1874), p. 44.

§ See 'Paper on Wood Pavements,' by R. S. Rounthwaite, Boro' Surveyor, Sunderland, 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. vii. p. 48.

deal blocks 4 or 5 inches deep, laid with a close joint upon a Portland cement concrete bed, the blocks being well grouted in with Portland cement grouting, their surface being afterwards sprinkled or strewn with sand or sharp gravel.

The woods employed for paving are beech and oak, larch, which is not easily procurable, elm, which is not durable, pitch pine and Baltic fir. Memel and Dantzic timber is better than Riga, the best wood for the purpose being said to be Wyborg or St. Petersburg red deals. Swedish yellow deals have been largely used in the metropolis, as well as American spruce, which is not very durable. And in addition to these is the Jarrah wood of which mention has already been made.

Whatever wood is employed, it is most important that all sappy wood must be at once rejected as unsuitable. This is a great objection to creosoting or other preserving processes, as it hides defects in the wood.

The advantages of wood paving may be summed up as follows:—

(1.) It is the quietest of all known pavements, wheels make scarcely any noise upon it and there is no clatter of horses hoofs.

(2.) It is much safer than either asphalte or granite pavements for horses travelling upon it, and if a horse falls he can rise more easily.

(3.) The traction necessary upon it, though slightly greater than upon asphalte, is compensated for by the better foothold given to horses.

(4.) It is clean. If well constructed there should be no mud made upon it; all that appears upon its surface should arise either from its being imported upon it, or from the gravel with which it is sometimes necessary to dress the surface.

(5.) It presents a uniform and slight elasticity, which is of great benefit to vehicles passing over it.

(6.) It may be laid on a gradient of 1 in 20 with safety to the traffic.

The principal objections to wood as a paving are :—

(1.) It is said to absorb moisture and to smell offensively, but this has often been refuted.*

(2.) It is said to be difficult to cleanse without the aid of water, as dirt adheres to the wood, and lingers in the joints.

(3.) It is not easy to open it or repair it, for the purposes of gas and water pipes, etc., and rather a large surface has to be removed for this purpose, and it has to be left a little time after repairs before traffic is again allowed on it.

(4.) The wood swells if wet, and cases are on record of the side kerbs of streets being raised, and lamp posts thrown down, by the pressure of the wood thus swelling.†

With regard to the cost of wood paving. This must vary in different localities, according to the value of labour, of materials, and in the manner in which the work is done.

The practice of most of the companies engaged in this class of work is to make a fixed charge per square yard for the pavement, including the concrete but excluding the excavation ; and they also guarantee to keep the pavement in repair free of charge for one or two years, and then for so many years after, at so much per yard per annum.

About 14*s.* per square yard is generally the first charge for constructing, and 1*s.* per square yard is the annual charge for maintenance.

* The Surveyor of the parish of St. George's, Hanover Square, London, says, "My experience of wood, and I have laid down 25,000 yards, is that it is perfectly free from smells, even on a cab rank." Report of a Committee of the Paddington Vestry on Wood and other Pavements (1878) p. 30.

† Mr. Allnut says on this : 'As to the swelling of the wood, it has been remarked that even brick walls have been forced out. We do not see what provision can be made for this; but leaving the channel by the kerbstone for the last work may relieve the lateral pressure, and perhaps it would be as well for the blocks not to be so dry when being laid down." *Vide* 'Wood Pavement as carried out on Kensington High Road, Chelsea, etc,' by Henry Allnutt (1880), p. 15.

Upon the subject of cost the following tables* may be useful:—

TABLE SHOWING THE ACTUAL DURATION AND COST OF CERTAIN WOOD PAVEMENTS IN THE CITY OF LONDON.

Situation.	Date when laid New.	Life.	First Cost per Square Yard.	Total Cost of Repairs per Square Yard during Life.	Average Cost per Square Yard per Annum.
		Yrs. Mths.	£ s. d.	£ s. d.	£ s. d.
Cornhill	May, 1855	10 2	0 12 2	0 17 4½	0 2 11
	July, 1865	6 8	0 11 6	0 8 9¾	0 3 0½
Gracechurch Street	Nov., 1853	11 7	0 12 8	0 17 1½	0 2 6¾
	June, 1865	6 0	0 11 6	0 6 11	0 3 0¾
Lombard Street ..	May, 1851	9 4	0 9 6	0 6 0	0 1 7¾
	Sept., 1860	10 7	0 9 2	1 0 2	0 2 9
Lothbury	May, 1854	12 3	0 12 6	1 8 4¾	0 3 4
	Aug., 1866	6 1	0 12 6	0 3 5¾	0 2 7½
Mincing Lane ..	July, 1841	19 1	0 14 4	0 13 4	0 1 5¼
	Aug., 1860	13 0	0 9 2	1 2 6¾	0 2 5¼
Bartholomew Lane	May, 1854	12 3	0 12 6	0 17 5¾	0 2 5¼
	Aug., 1866	5 5	0 12 6	0 3 11¼	0 3 0¼

Foundations are included, but no excavation.

* *Vide* 'Report on Asphalte and Wood Pavements,' by William Haywood, 1874, pp. 38 and 41.

TABLE SHOWING FIRST COST, AND TENDERED COST PER ANNUM FOR MAINTAINING CERTAIN WOOD CARRIAGEWAY PAVEMENTS IN THE CITY OF LONDON.

Situation.	Date when Laid.	Name of Contractor.	Years to be maintained by Contractor.	First Cost per Square Yard.	Agreed Cost of maintenance per Square Yard for the Contract Term.	Total Cost of Pavements during Contract Term, per Square Yard.	Average Cost per Square Yard per Annum.
				£ s. d.		£ s. d.	£ s. d.
King William Street	Feb., 1873	Improved Wood Paving Co.	16	0 18 0	1 year free 15 years at 1s. 6d. = 1l. 2s. 6d.	2 0 6	0 2 6¼
Ludgate Hill ..	Nov., 1873	Ditto	16	0 18 0	1 year free 15 years at 1s. 6d. = 1l. 2s. 6d.	2 0 6	0 2 6¼
Portions of Great Tower Street and Seething Lane ..	Sept., 1873	Ditto	16	0 16 0	1 year free 15 years at 1s. 3d. = 18s. 9d.	1 14 9	0 2 2
Bartholomew Lane	Jan., 1872	Carey	No agreement.	0 12 6	—	—	—
Ditto	Dec., 1871	Improved Wood Paving Co.	3	0 16 0	3 years free	0 16 0	—
Duke Street	May, 1873	Mowlem and Co.	*5	0 15 0	2 years free 3 years at 1s. = 3s.	These pavements will no doubt last some years longer than the contract term of maintenance.	
Houndsditch ..	Not yet laid	Ditto	*7	0 17 0	2 years free 5 years at 9d. = 3s. 9d.		
Ditto	Ditto	Carey	*7	0 13 6	2 years free 5 years at 1s. = 5s.		

In the wood pavements the cost of the foundation is included, but no excavation.
The pavements at the end of each financial year are to be in a good sound condition.

* The Ligno-Mineral Paving Company and the Improved Wood Paving Company offered to maintain their pavements, if laid, for terms of ten years and fourteen years respectively; their tenders were not accepted.

The following table* is also given as showing the comparative cost of wood paving with macadam and bituminous concrete paving in Liverpool.

Description of Pavement.	Original Cost per Square Yard at present prices.	Deductions from First Cost to determine Cost of Renewal.		Interest on Original Cost at 4½ per cent. per Square Yard per Annum.	Sinking Fund invested at 3 per cent. Compound Interest.	Maintenance per Square Yard per Annum.	Scavenging per Square Yard per Annum.	Gravelling per Square Yard per Annum.	Total Annual Cost per Square Yard.
		Cost of Foundation not requiring renewal.	Allowances for old Materials at date of renewal.						
	s. d.	*s. d.*		*d.*	*d.*	*s. d.*	*d.*	*d.*	*s. d.*
No. 6. Bituminous Concrete Pavement	3 9	Nil	Nil	2·0	Nil	0 9	2·4	..	1 1·4
No. 7. Wood Pavement ..	15 1·5	2 0	Nil	7·5	4·3	0 1·0	2·7	5·0	1 8·5
No. 8. Macadam Pavement	6 9	Nil	Nil	3·4	Nil	1 0	8·0	Nil	1 11·4

* *Vide* 'Paper on Street Carriageway Pavements,' by G. F. Deacon, 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 23.

In concluding this chapter upon wood paving, I will give a few heads for the preparation of a specification for work of this description.

Excavation.—Excavate the ground to a depth of inches below the level of the proposed finished surface of the roadway.* The formation surface thus excavated must be well watered and rolled and punned if found necessary, and any soft or made earth removed to such a depth as may be found to be sufficient.†

Foundation.—Upon the excavated formation surface a bed inches thick of concrete is to be laid, composed of one part of good, approved Portland cement to two of fine, sharp river sand, and three of clean river ballast or broken stone. The concrete to be finished off with an even and smooth top surface conforming with the contour line of proposed finished roadway.

Wood Blocks.—Upon the concrete thus laid, and after it has sufficiently set, wood blocks are to be laid.‡ These blocks must be of the best description of Baltic red timber§ (or such other timber as shall be specified), sound and thoroughly well-seasoned, free from all sap, shakes, large and loose knots or other defects, and any that may be rejected by the surveyor as unfitted for the work shall be at once removed from the works or broken up. The blocks must not be less than 6 inches or more than 12 inches in length by 3 inches in width and 6 inches in depth; they are to be carefully laid with the fibre of the wood placed vertically, their

* If the road material thus excavated is macadam, it may be screened and used as concrete in the foundation, if approved by the surveyor. The granite pitching of crossings, channel gutters, etc., must remain the property of the sanitary authority, as well as the surplus macadam.

† It is important to give sufficient notice to gas and water companies in order that they may attend to their mains and services before the foundations are put in.

‡ Sometimes about half an inch of fine sand is spread upon the surface of the concrete upon which the wood blocks are bedded.

§ If the blocks are to be creosoted, the number of pounds of creosote that should be absorbed in a cubic foot of the wood should be specified; this is generally about 10 lbs. of creosote to 1 cubic foot of wood.

ends must butt with close joints to each other, and each course must be kept $\frac{3}{8}$ of an inch apart by means of wooden laths, which are afterwards removed.

Joints.—The joints are then to be carefully run with a grouting composed of one part of best approved Portland cement to two parts of fine, sharp, clean river sand. In some cases a hot bituminous mixture or asphalte is run between the joints as a grouting.

Top Dressing.—The whole surface of the pavement is then to be spread with a coating, at least $\frac{1}{2}$-inch in thickness, of fine sharp gravel or chippings.

The following heads of general conditions under such a contract may also be useful.

Alteration of gullies, sewer man-holes, etc., will be done at the expense of the sanitary authority.

Contractor must make good at once any damage caused to gas or water mains or services—time penalty for delay.

Maintenance of work after completion for a specified time.

Power must be reserved to surveyor to suspend work during bad weather or from other causes.

Heavy time penalties for non-completion of contract by a certain date.

Payments to be made to contractor on surveyor's certificate, up to 80 per cent. of whole contract, remaining 20 per cent. to be paid at end of (say) 2 years after completion.

In conclusion I cannot do better than draw attention to Mr. Stayton's paper on Wood Pavement in the Metropolis, by George Henry Stayton, which may be found in Vol. lxxviii. of the Minutes of Proceedings of the Institution of Civil Engineers, and which gives a large amount of useful information upon this subject.

CHAPTER X.

COMPRESSED ASPHALTE ROADWAYS.

THE word asphalte, in its generally accepted sense, implies a natural rock consisting of pure carbonate of lime, intimately combined and impregnated with mineral bitumen in very variable proportions; that used for roads or footpaths should not contain less than 7 or more than 12 per cent. of bitumen.

The rock, when broken, takes an irregular fracture without definite cleavage; it is principally derived from Val de Travers, Seyssel, Sicily, Chieti, Auvergne, Lobsann, and Limmer. Its grain should be regular and homogeneous, the finer the grain the better.*

When exposed to the atmosphere asphalte gradually assumes a grey tint, by reason of the bitumen evaporating from the surface leaving a thin film of limestone behind. The stone is usually taken from open quarries, but at Val de Travers shafts are sunk, and the general treatment is similar to a coal mine.

Bitumen, it must be borne in mind, is itself a mineral product found in Trinidad and some other places; it is composed of carbon, hydrogen, and oxygen.

The weight of a cubic yard of natural asphalte is about 3874 lbs., its specific gravity is 2·114, but this of course varies with its percentage of bitumen.

The following is a test for asphalte given by Mr. Delano in a paper he read before the Institution of Civil Engineers in the year 1880.†

* In this respect the Seyssel is the best, being of a very fine grain.

† *Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lx.

"A specimen of the rock freed from all extraneous matter, having been pulverised as finely as possible, should be dissolved in sulphurate of carbon, turpentine, ether or benzine, placed in a glass vessel, and stirred with a glass rod. A dark solution will result, from which will be precipitated the pulverised limestone. The solution of bitumen should then be poured off. The dissolvent speedily evaporates, leaving the constituent parts of the asphalte, each of which should be weighed so as to determine the exact proportion. The bitumen should be heated in a lead bath, and tested with a porcelain or Baumé thermometer to 428° Fahr. There will be little loss by evaporation if the bitumen is good; but if bituminous oil is present the loss will be considerable—gritted mastic should be heated to 450° Fahr. The limestone should next be examined. If the powder is white and soft to the touch it is a good component part of asphalte, but if rough and dirty on being tested with reagents, it will be found to contain iron pyrites, silicates, clay, etc. Some asphaltes also are of a spongy or hygrometrical nature. Thus, as an analysis which merely gives so much bitumen and so much limestone may mislead, it is necessary to know the quality of the limestone and of the bitumen.

"For a good compressed roadway an asphalte composed of pure limestone and 9 to 10 per cent. of bitumen, non-evaporative at 428° Fahr., is the most suitable. Asphaltes containing much more than 10 per cent. of bitumen get soft in summer, and wavy; those containing much less have not sufficient bind for heavy traffic, although asphalte containing 7 per cent. of bitumen, properly heated, does well for court-yards, as it sets hard when cold."

For roadways "compressed" asphalte should be used, and not "mastic," which is only fitted for footpaths, court-yards, etc. Compressed asphalte roadways are constructed as follows:—

The asphalte rock is first crushed in a "Blake's" or other

suitable crusher, and then pulverised in a "disintegrater," until it is reduced to a fine powder, so that it will pass through a sieve of 0·1 square inch mesh. This powder is then heated up to between 240 degrees and 250 degrees Fahrenheit in cylinders, which are kept revolving so that each particle may become heated without burning, and still remain separate from its neighbour. The powder is then carefully transported to the street, where it is to be laid in iron-covered carts, in order that it may not lose more than 20 degrees of heat during transit.

The powder must then be spread upon the concrete in an even layer, about $2\frac{2}{3}$ inches in depth, and be carefully raked so as to have regularity of depth and surface. Great care must be exercised to ensure that the face of the concrete shall be perfectly dry before the asphalte powder is laid on it, otherwise the moisture is sucked up into the powder, turned into steam, which tries to escape through the heated powder, and fissures are formed, which may not appear until after the roadway has been made some little time. Such a result will lead to the disintegration of the mass, with the consequence that the material breaks up.

After the powder has been laid and raked, it must be well rammed with iron punners, weighing about 10 lbs., heated so as to prevent the adhesion of the powder. This ramming must be done lightly at first so as to ensure equality of thickness, and afterwards augmented to heavy blows. After being thus rammed, the pavement must be smoothed by a suitable curved hot iron tool, after which it is again vigorously rammed and rolled until it is quite cool. The roller must weigh about 1,100 lbs.

Within a few hours of the completed compression of the asphalte, the road is ready for traffic, a light sprinkling of sand being first applied to its surface.

A roadway thus prepared presents many advantages over

macadam, granite setts or wood, the following passage amply describing one of them :*

"An indispensable feature of a weight-carrying pavement must be the absolute exclusion of water at the surface as nearly as it can be insured, and in this one respect it cannot be questioned that a surface like asphalte has no equal, the absorption being so gradual as to be inappreciable during any possible continuance of moisture."

In addition to this indisputable fact, the advantage of durability is claimed for asphalte, but this must vary considerably with the quality of the material and of the work. Mr. Haywood estimates the life of an asphaltic Val de Travers compressed roadway at 17 years, and it is claimed for it that it will wear until it becomes quite thin, very heavy traffic breaking it up when it is worn to about $\frac{3}{4}$ of an inch thick. Another advantage claimed for asphalte is cleanliness, and this is evidently indisputable, as, being impervious, none but imported mud or dust can be formed upon it.

In addition to the foregoing the following advantages are also claimed :—

Pedestrians can walk on asphaltic roadways as well as on the footways.

It is comparatively noiseless under traffic, though in this case wood is better, as the clatter of the iron-shod horses' feet upon asphalte is very apparent.

It is expeditiously laid, and when repairs are necessary they can easily be effected ; no pavement shows less signs of openings being made in it for gas and water-pipes repairs than asphalte, when these repairs are properly executed.

The rapid laying causes less inconvenience to traffic in the streets.

Ease of traction; but here steps in the one great

* *Vide* Mr. Howarth's paper on 'Wood as a Paving Material under Heavy Traffic,' 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lviii. p. 35.

objection to asphalte as a roadway paving, viz. danger to horses by slipping and falling, of which I shall say more hereafter.

Cellars and vaults under the streets are kept dry, by reason of its impermeability to moisture.

Easily cleansed, especially by mechanical sweeping, and snow is easily removed.

It is very pleasing to the eye, being so uniformly regular and of good colour.

There is no vibration or concussion in travelling over it, and apart from the question of safety it is delightful to drive over it.

It is a cool pavement at night; it does not absorb heat during the day, and consequently none radiates from it after the sun has gone down.*

The great objection to asphalte as a material for roadways arises from the fact that it is extremely slippery when damp,† irrespective of temperature, and this in the climate of England is frequently the case. The result of this slipperiness is, that not only do horses frequently fall upon it, but it is also difficult to stop a horse when drawing a load, thus causing more risk to foot-passengers of being run over, and straining the horse considerably in its efforts. Again, in thoroughfares crowded with vehicular traffic, constant stoppages occur, and in starting again it is painful to witness the struggles of the horses to keep their footing and overcome the inertia of their load. When a horse falls he has very great difficulty in rising, but on the other hand, although he may be strained, a horse never breaks his knees upon this class of pavement. How far this

* In Paris and other cities liable to civil war or internal commotions, it is contended as an advantage of asphalte that it cannot be used for the construction of barricades, breastworks, or rifle pits.

† *Vide* Mr. Haywood's Report upon Asphalte and Wood Pavements, also 'Report on the Application of Science and Art to Street Paving and Cleansing of the Metropolis,' and numerous other pamphlets and reports by eminent authorities upon the subject.

might be altered if *all* the streets of a town were paved with asphalte, is a fair matter for argument, as it is asserted that horses are very nervous on going from one pavement to another, and accidents frequently happen in consequence.

The strewing of sand upon asphalte renders it less slippery, but in addition to the interference of the traffic whilst this is being done, there are the further objections of the possible injury of the sand cutting into the asphalte, the expense of labour and materials, and the mud caused thereby which has afterwards to be removed. Another plan is to frequently wash the asphalte with water, but this is expensive and only of temporary benefit.*

Another objection to asphaltic roadways is that they cannot with safety be constructed of greater gradient than 1 in 60, and it must also be borne in mind that fine weather is necessary both for the construction and repairs of a roadway of this description.

Very little smell, and that not of an unpleasant character, arises from the work when compressed asphalte is being used; the mastic is, however, temporarily unpleasant to those who dislike the odour.

With reference to the question of the cost of compressed asphalte for roadways: it is of course a matter depending upon local circumstances as to the first cost, but it must be remembered that the compressed asphalte hitherto laid has

* I believe that in Berlin, where there are many miles of streets laid with asphalte, the objection to it is being somewhat overcome by the fact that the horses and drivers are getting more used to it, and by keeping the asphalte scrupulously clean. This is a most important point. If perfectly dry and clean, or thorougly wet and clean, asphalte is by no means a slippery pavement. As a proof of this, showing what greater care in this direction will effect, it appears that in the year 1885, in Berlin, 4,403 horses fell on 400,000 square yards of asphalte; in the year 1887 there were only 2,456 falls on 490,000 square yards of this pavement; and the large horse owners of this city petitioned that more streets should be laid with this material, as the ease of traction was so great a saving to them.

been nearly all that of the Val de Travers Company, who charge a fixed price per square yard for laying according to thickness required, the distance of the locality from London, and other local circumstances. With reference to maintenance, this is a question dependent mainly upon traffic, but here again the company will undertake to keep in repair at so much per square yard per annum for a certain number of years.

It would, however, perhaps be a better plan not to enter into such an agreement, but to arrange for repairs under a schedule of prices; but this must greatly depend upon the character of the work in the first place, and other local considerations.

Mr. Ellice Clarke gave the following as the cost of Val de Travers compressed asphalte* in the year 1878, but since then the first cost has materially diminished, as will be seen on reference to the table on the next page.

Original Cost per Square Yard.	Interest on original Cost.	Maintenance per Square Yard.	Scavenging per Square Yard.	Total.
s. *d.*	*d.*	*d.*	*d.*	*s.* *d.*
18 0	9·7	3·6	0·4	1 1·7

Nothing is charged for renewal, as the annual sum for maintenance provides the asphalte in perpetuity.†

The table on next page, as it is the latest information upon this subject, may here be of use.

With the one serious objection of slipperiness, compressed asphalte seems a most suitable material for the surface of a

* *Vide* 'Asphalte and its Application to Street Paving,' by E. B. Ellice Clarke, 'Proceedings of the Association of Municipal and Sanitary Engineers,' vol. vi. p. 52.

† The asphaltic roadways of Paris, of which there were 290,000 square yards in the year 1878, cost from 10*s.* to 12*s.* per square yard to lay, and about 8·83 pence per square yard per annum to maintain, including the charge for renewing $\frac{1}{10}$th part of the surface every year, which is the method adopted there. *Vide* 'Annales Industrielles,' 1878.

TABLE SHOWING COST PER ANNUM OF CERTAIN ASPHALTE PAVEMENTS IN LONDON.

Situation.	Description of Asphalte.	Years to be maintained by Contractors.	First Cost per Square Yard.	Agreed Cost of Maintenance per Square Yard for the Contract Term.	Total Cost of Pavements during Contract Term per Square Yard.	Average Cost per Square Yard per Annum.
			£ s. d.		£ s. d.	£ s. d.
New Oxford Street ..	Val de Travers (Compressed)	17	0 12 6	2 years free; 15 years at 10d. = 12s. 6d.	1 5 0	0 1 5½
Minories	Ditto	17	0 12 6	2 years free; 15 years at 9d. = 11s. 3d.	1 3 9	0 1 4⅝
Great Russell Street ..	Ditto	17	0 12 6	2 years free; 15 years at 6d. = 7s. 6d.	1 0 0	0 1 2½
Tottenham Court Road	French Asphalte (Compressed)	17	0 13 6	2 years free; 15 years at 10d. = 12s. 6d.	1 6 0	0 1 6½
Coleman Street	Ditto	17	0 12 0	2 years free; 15 years at 3d. = 3s. 9d.	0 15 9	0 0 11½
Southampton Row ..	Ditto	17	0 12 6	2 years free; 15 years at 6d. = 7s. 6d.	1 0 0	0 1 2½
Red Cross Street	Limmer (Compressed)	17	0 12 0	2 years free; 15 years at 9d. = 11s. 3d.	1 3 3	0 1 4½
Golden Lane	Ditto	17	0 12 0	2 years free; 15 years at 8d. = 10s. 0d.	1 2 0	0 1 3½

roadway, but that objection is of considerable weight when we reflect that the great object of roadways is that of "traffic," and it is for that purpose they are constructed; still, in cities where a heavy *business* traffic is going on, this class of roadway has so many advantages that where cheap horses are driven it might be used; where, however, valuable horses are used for pleasure driving, as in the West End of London and the corresponding better parts of cities, some other description of roadway should be maintained.

Mastic asphalte will be described in the chapter on footpaths.

Hints for a Specification for a Compressed Asphalte Roadway.

The foundation must be made, as in the case of stone or wood pavements, of the best and hardest concrete, the top surface of which must be floated up to a smooth and perfect contour.

The asphalte rock must be crushed in a stone-crusher, such as I have already described, and then pulverised in a "disintegrater," until it is reduced to a fine powder, so that it will pass through a sieve of 0·1 square inch mesh. This powder is then heated up to between 240 degrees and 250 degrees Fahrenheit in cylinders, which are kept revolving so that each particle may become heated without burning, and still remain separate from its neighbour. The powder is then carefully transported to the street where it is to be laid, in iron-covered carts, in order that it may not lose more than 20 degrees of heat during transit.

The powder must then be spread upon the concrete in an even layer, about $2\frac{3}{8}$ inches in depth, and be carefully raked so as to have regularity of depth and surface. Great care must be exercised to ensure that the face of the concrete shall be perfectly dry before the asphalte powder is laid on it; otherwise the moisture is sucked up into the powder, turned

into steam, which tries to escape through the heated powder, and fissures are formed, which may not appear until after the roadway has been made some little time. Such a result will lead to the disintegration of the mass, with the consequence that the material breaks up.

After the powder has been laid and raked, it must be well rammed with iron punners, weighing about 10 lbs., heated so as to prevent the adhesion of the powder. This ramming must be done lightly at first so as to ensure equality of thickness, and afterwards augmented to heavy blows. After being thus rammed, the pavement must be smoothed by a suitable curved hot iron tool, after which it is again vigorously rammed and rolled until it is quite cool. The roller must weigh about 1,100 lbs.

Within a few hours of the completed compression of the asphalte, the road is ready for traffic, a light sprinkling of sand being first applied to its surface.

One of the principal reasons of durability in asphalte pavement is its elasticity, and it should be remembered that compressed asphalte does not begin to "wear" until all compression has ceased; this is the case with no other system of pavement—stone and wood both begin "wearing" from the day the traffic commences. Under ordinarily heavy traffic it may be estimated that it will take two years to complete the compression of asphalte, and the weight of a square foot of this pavement will at the expiration of that time be nearly the same as on the day it was laid, though the thickness is reduced during the first two years as much as it will be in the following eight.

Much is said about the advisability of *good* and *dry* concrete; but it may be as well to explain the reasons that necessitate so much care in the foundation. First, it should be always borne in mind that asphalte pavement is nothing more than a tough "carpet," and has no power of itself of offering resistance to heavy traffic; consequently, if the

substratum or concrete is not thoroughly solid and resisting, the weight of traffic will crush it, and the asphalte will at once give way in all directions. The concrete should be made strong enough to resist the traffic, and the asphalte is a simple covering to protect the concrete from direct contact with the wear and friction caused by the traffic. So much for the strength, but the dryness is of even still greater importance; for the best asphalte, laid by skilled workmen, on thoroughly first-rate but damp concrete, will rapidly go to pieces—a phenomenon takes place, which, although quite natural, is little realised by most engineers. When the hot asphalte is laid, the water is immediately sucked up and turned into steam, which tries to escape through the heated powder, and the result is that although the surface of the asphalte is smooth, the mass is really disintegrated from underneath by its bitter enemy "water," and as soon as the surface begins to wear, the fissures formed by the passing of the steam appear on the surface and the whole pavement falls to pieces: thus accounting for some of the failures this description of roadway has met with under unskilled treatment.

This completes the subject of roadways; I will turn to that of footpaths in the next chapter.

CHAPTER XI.

FOOTPATHS.

As in the case of roadways, so with footpaths: the foundation is of primary importance, whatever material may be used for the surface. For some materials, notably asphalte, concrete is essential as a foundation. For gravel, tar paving, or other similar surface, a hard core bottom well drained is sufficient. The materials of which a footpath can be formed are very various, but the following may be given as embodying most of them :—

(1.) Natural asphalte, compressed and mastic.
(2.) Yorkshire flagging—Caithness flagging, etc. etc.
(3.) Blue lias, and Devonian limestone flagging, slates, etc.
(4.) Concrete in monolith, or slabs.
(5.) Bricks or tiles.
(6.) Granite slabs.
(7.) Artificial asphaltes, including tar pavement.
(8.) Gravel, stone chippings, etc.

First on the list stands natural asphalte, compressed and mastic.

The compressed has been thoroughly described in the preceding chapter; it is generally used for footpaths where there is a very heavy traffic, and answers admirably.

I will, however, now deal solely with mastic asphalte, which means the rock ground to powder, mixed with a certain proportion of bitumen to act as a flux, and then subjected to heat; this is sometimes used in conjunction with fine sharp clean river sand, but more often with finely crushed stone

about the size of peppercorns, and is styled "gritted asphalte."

As long ago as the year 1838, Mr. F. W. Simms speaks of asphalte mastic from Pyrmont, near Seyssel, and says "it may be considered a species of mineral leather"*—a very good description of its surprisingly tough, hard, durable and pliant properties.

The usual method of the preparation o the mastic is as follows:—

According to the amount of bitumen contained in the natural stone, from 5 to 8 per cent. of refined Trinidad bitumen† is placed in a large caldron which is usually provided with agitators driven by steam power; when this is thoroughly melted, the powdered asphalte is added little by little, the heat being raised to between 390 and 480 F., the mixture kept well stirred and "cooked" for about five hours. It is then turned out into iron moulds, most companies having a special pattern with a trade mark for this purpose.

The caldrons generally used contain from 1½ to 2 tons of mastic.

Some companies in large towns are provided with caldrons on wheels, commonly called "Locomobiles," in which case the grit is mixed with the mastic in the fixed caldrons, and the whole mass run out into the locomobiles (which are also provided with agitators worked by an endless chain attached to the axle of the wheels), and transported direct to where the work has to be done. This system, though undoubtedly the best, is not practicable except in large towns; the more usual method of laying mastic footpaths is to send the asphalte cakes to the works, where they are remelted in small

* *Vide* 'Proceedings of the Institution of Civil Engineers,' vol. i. p. 6.

† Trinidad bitumen is best, but it has to be refined before it can be used. This is done by cooking it with shale oil, then straining it and decanting it, which is a troublesome and tedious process, and there is great danger of fraud being practised. Good bitumen can be detected by its elasticity and softness when rolled between the finger and thumb, and also by its smell.

round street caldrons, containing from 8 to 12 cakes each, weighing from 40 to 50 lbs., the grit being sometimes added in the fixed caldrons, sometimes in the street caldrons, this amount of grit varying from 20 to 60 per cent. according to the nature of the work.

The grit makes the asphalte more difficult to spread, but it lessens the cost and make a very durable path. The affinity between the asphalte and grit is so great that, in breaking a sample, the actual pieces of grit will be found broken in half.

The asphalte should be spread from $\frac{1}{2}$ to $\frac{7}{8}$ of an inch in thickness (if compressed 1 inch is the minimum), and should be brought hot on to the works in covered caldrons on wheels; the test of its being ready and fit to lay, being made by plunging a wooden spatula into it, which should come out without any of the asphalte adhering to it, and also by jets of light smoke darting out of the mixture.

The mastic should be taken from the caldron with a warmed ladle, and put into buckets previously heated, then thrown out on the concrete (which should be perfectly dry) near the spreader, who spreads it skilfully with a wooden stave, spreader, or spatula. The surface should then be floated and dusted over with fine sand, Portland cement, or stone dust.

Dishonest contractors sometimes substitute inferior materials for natural asphalte, such imitations being made of ground chalk, fire-clay, and pitch or gas tar, or ground limestone mixed with bitumen.

A sample of the footpath after it is laid should be cut out (this is easily effected by heating the surface with a piece of hot mastic), in order to see that the proper thickness is given, and by applying a light to the sample, the smell will readily tell if real asphalte or any inferior material has been used. Stockholm tar or common pitch should not be allowed to be substituted for Trinidad bitumen, or it will spoil the mastic.

Asphalte mastic footpaths are excellent in every way, the only objections to them being the necessity for the grit, and the temporary unpleasant smoke and smell whilst being laid. It is also necessary to put stone sills round the cellar openings and coal shutes, etc., for the asphalte to butt against, but it makes an invaluable pavement, especially for courts, alleys, back yards, etc., for sanitary and other reasons.

The proportions of asphalte, bitumen and grit are given as follows by Mr. Delano in his translation of a paper by M. Ernest Chabrier, on the applications of asphalte.*

"One ton of sanded mastic requires 13 cwt. of pure block mastic, 2 qrs. 12 lbs. of bitumen, 7 cwt. of grit or sand washed and dried," and it takes 2 cwt. of coal to heat it. He further says that one workman can easily prepare 3 tons of material in 12 hours.

The following table gives the number of square yards that a ton of prepared Sicilian rock asphalte will spread :—

Without grit.	With about 25 per cent. of grit.	Thickness.
square yards.	square yards.	inches.
63	80	¾
51	65	⅞
32	40	1¼
26	33	1
16	20	1½
12½	16	2

A skilled workman properly assisted can lay 140 to 180 square yards in a day.†

With regard to the price of asphalte mastic footpaths, this is quite a local question, and is not worth while discussing. The life of a footpath thus treated may be reckoned at about 15 years under ordinary traffic; the concrete will remain untouched, and what is left of the asphalte may be remelted, so that a renewal is not so costly as the first expense.

* *Vide* 'Proceedings of the Institution of Civil Engineers,' vol. xliii. p. 293.

† *Ibid.* vol. xliii. p. 293.

Yorkshire Flagging.—This pavement is too well known to need any description from me; it is an excellent pavement in many ways, and is most pleasant to walk upon, there being a cling or foothold not experienced in any other material.

The objections to this description of pavement are :—

(1.) Its first cost, which is undoubtedly high as compared to its durability.

(2.) The fact of uneven wearing: one stone will be found soft next to a hard one; the former wears, leaving a pit which forms a pool for water in due course, and has to be removed.

(3.) Unless very carefully bedded, a stone will see-saw; this is very unpleasant in wet weather, water accumulates beneath, and as the pedestrian treads on one end of the stone a squirt of dirty water up to his knees, and a stumble, remind him that the stone is loose.

(4.) Liability to crack when any heavy goods are thrown upon it.

The following specimen specification for Yorkshire flagging pavement may be of use :—

Specimen Specification for Yorkshire Flagging Foot Pavements.

The old flagging (where and when directed) to be taken up, refaced, squared, and relaid.

The new flagging is to be chisel-dressed to a fair face, true, out of winding, and not less than 3 inches thick,* to be properly squared and not pitched off only, or undercut, but to hold good to the square; to have not more than fourteen pieces to the hundred superficial feet; the joints must be set flush, and bedded and pointed with the best blue lias mortar.

The bed for the flagging both old and new, if any is required, to be made with proper earth, gravel, or dry rubbish,

* A rule is sometimes made that York flags should be ½ inch thick for every square foot of surface, but they should never be less than 2 inches thick.

and all surplus earth and rubbish to be carted from the streets as it arises from the works.

The flagging to be properly cut and rebated to receive all area gratings, coal shoots, rain-water troughs, &c.

Any damage done to gas or water-service pipes in digging for the flagging, or in any way connected with the work, to be made good by the contractor, as also all and every other damage to windows, wood, or glass work; and the contractor will be held responsible for, and will make compensation for any injury that the public may sustain through the negligence of his workmen, or otherwise.

The whole of the flags to be of the very best quality, from Halifax, the quarries in the neighbourhood of Bradford or in Yorkshire, and subject to the approval of the Surveyor.

The contractor to provide all lights and proper guards at night, and when old paving is to be taken up the work is to be done under the direction of the surveyor, and if considered necessary, the stones are to be removed from the streets to be re-faced and squared. No stone to be stacked in the streets.

The flagging to be measured after the work is completed.

The contractor to provide all stone, materials, tools, implements, horse and cart hire, and pay all railway dues, freightages, etc.; and also to provide all labour of every kind for properly completing the work to the full and entire satisfaction of the surveyor. Payment will be made as the work proceeds, on the certificate of the surveyor.

Should the contractor fail to perform the work to the satisfaction of the surveyor, he then shall have power to execute the work and charge the same to the contractor, and deduct the cost from any amount that may be due to him; and in the event of the cost being more than the amount due, or if there shall then be no sum due to the contractor, such cost shall be paid by the contractor to the mayor, aldermen and citizens, and the same shall be recoverable from him as liquidated and ascertained damages.

Caithness Flagging is now used very largely instead of Yorkshire ; it comes from Thurso in Scotland, and it is contended for it that it possesses many excellent qualities ; amongst others may be enumerated the following :

(1.) It is impervious to wet.

(2.) It is not slippery nor does it wear so.

(3.) It does not scale or flake.

(4.) It dries rapidly after rain.

(5.) Its appearance is cheerful.

(6.) Great durability, as it does not abrade.

(7.) Frost has no effect upon it.

(8.) Can be re-used when half worn.

(9.) Cleanliness ; for, not being porous, no dirt or dust can adhere to it.

(10.) Vehicular traffic may be turned over it without injury to the path.

(11.) Economy ; as natural faces can be used, thus saving labour, and it can be laid from 1½ to 2 inches thick only.

(12.) Having sawn edges, the joints are expeditiously and well made.

(13.) Its whole surface wears evenly.

The following table was compiled by the well-known firm of Kirkaldy, by direction of the late Mr. Tarbottom, the Borough Engineer of Nottingham, in order to ascertain the resistance to a gradually increased bending stress upon Yorkshire flagging as compared with Caithness.

YORKSHIRE.

Test No.	Weight.	Dimensions.			Ultimate Stress.
		Length.	Breadth.	Thickness.	
K	lbs.	inches.	inches.	inches.	lbs.
1918	184	36	24·07	2·46	4·744
1919	163	36	24·03	2·22	3·398
1920	107	36	23·90	1·50	1·459
Mean	151	36	24·00	2·06	3·200

CAITHNESS.

Test No.	Weight.	Dimensions.			Ultimate Stress.
		Length.	Breadth.	Thickness.	
K	lbs.	inches.	inches.	inches.	lbs.
1921	215	36	24·06	2·59	17·274
1922	178	36	24·05	2·15	12·711
1923	114	36	23·90	1·38	6·211
Mean	169	36	24·00	2·04	12·065

By which it appears that the balance in favour of Caithness flagging is 8·865 lbs.

Blue Lias Flagging.—A blue lias flagging does not make a first-rate pavement, as, although it is very cheap, durable, clean, and has many other good qualities, it sometimes wears slippery and is then dangerous to pedestrians: but the Devonian limestone, which is much used in the west of England has not apparently this defect.

Concrete Footpaths.—The use of concrete, as a monolith, and also in slabs, as a paving material for footpaths, has made great progress during the last few years, and in nearly every town in the United Kingdom more or less concrete may now be seen as a pavement upon the footpaths.

When this description of pavement was originally laid in mass with large exposed surfaces, great alterations took place on changes of temperature, and the concrete either cracked or gaped open, or in some cases rose up from its bed into arches and curves. The cure for this has been to lay the concrete in bays of about six feet in width, completing each bay alternately, allowing the intermediate one to set before the neighbouring bay is commenced.

Another method is to leave laths or strips of soft wood between the widths of concrete, and subdividing those widths by cutting into the concrete with a trowel before it is quite set, thus splitting up the mass of concrete and giving it plenty of room to expand.

The following may be taken as a fair description of the manner in which monolith concrete footpaths should be constructed.

Excavate the ground to a depth of about 5 inches below the finished level, and upon this lay an even bed about 1 inch in thickness of cinders or gravel; upon this lay a layer of clean hard stone or other suitable material, broken so as to pass through a 3-inch ring, well water and roll, filling up inequalities and leaving the surface about 2 inches below the finished level of footpath. Divide into bays as described above with battens of soft wood, and complete each alternate bay by laying upon the stone foundation carefully prepared concrete composed of 1 part Portland cement, 2 parts coarse clean gravel, or other suitable and procurable material, passed through a 1-inch screen, and 2 parts of clean sharp sand, which must be well beaten or rolled into place; and before it is set a finishing coat 1 inch in thickness of a finer and richer concrete is to be added and brought up to the finished surface of the footpath, and well trowelled and smoothed into place. This finishing coat may be composed of 1 part Portland cement to 2 parts granite chippings, Oporto gravel or other suitable material which will pass through a quarter-inch sieve.*

As the work is finished the battens may be removed and the joints filled with fine sand.

As concrete footpaths are somewhat more slippery than natural stone, a cross fall of three-eighths of an inch per foot is sufficient.

In the construction of concrete footpaths great care is necessary that the materials should be perfectly clean and well washed, and that none but the best Portland cement, ground very fine, should be used, and that the concrete should be most carefully mixed.

* The selection of suitable materials must depend to a great extent upon locality, but the grit or gravel for the finished surface must not be "rounding," or it will become displaced by the feet of pedestrians.

Traffic should be prevented until the concrete is thoroughly set, either by diverting it, or by covering the footpath with planks for about a fortnight. In hot, dry weather the concrete should be covered with a coating of sand and kept thoroughly damp.

From a return prepared in 1889 by Mr. Macbrair, the City Surveyor of Lincoln,* out of 29 towns from which replies were received, 19 had footpaths laid with monolith concrete, which had cost from 1*s.* 8*d.* per square yard up to 5*s.* 6*d.*, and the majority of the surveyors' opinions were in favour of this class of foot pavement.

In the first edition of this book I gave, *in extenso*, a description of the method employed in the United States for the construction of this class of footpath, but it is scarcely necessary to repeat the detail particulars, as they may be found in "Roads, Streets, and Pavements," by Q. A. Gillmore, page 208.

Under the head of Concrete may be included many artificial stone pavements, such as "Bucknell's Granite Breccia," "Imperial Stone," "Ransome's Artificial Stone," "Eureka Concrete," "Ferrumite," "Granolithic," "Wilkinson's Granite Concrete," "Silicated Victoria Stone," and others. Some of these are laid *in situ*, whilst others are made in the form of slabs, usually about 2 inches in thickness and of varying sizes so as to suit the widths of footpaths. A cheap and good slab may be made of fine Portland cement concrete well rammed into wooden moulds lined with iron, which are oiled to prevent adhesion. When sufficiently set the moulds are taken to pieces, and the slabs may then be placed in a bath, or stacked in the open air, special precautions being taken in frosty weather, until they are thoroughly matured. This description of pavement is cheap, as it can be made and laid for 3*s.* per square yard, where shingle is easily procurable.

* *Vide* 'Minutes of Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. xv. p. 189.

The blocks are of uniform size and give an even "break joint," the colour is pleasing, they wear evenly and are indifferent to changes of temperature, are easily cleansed and dry rapidly after rain, and if evenly and securely bedded will stand considerable shocks. When one surface is worn they can be turned over, though, as the face is made of stronger material, the under side is not so durable; still from the long period during which they have matured whilst wearing on the face, there is considerable life left in the lower surface which may be used for streets of lighter traffic.

Brick Footpaths.—Ordinary bricks were no doubt formerly used for paving footwalks in some districts, because no better material could be procured except at a prohibitive price; eventually hard vitrified stoneware bricks were introduced in Staffordshire, with a chequered or diamond-pattern surface, and these bricks have been extensively used ever since, principally on account of their cheapness and durability. In West Bromwich, for instance, a pavement of this description only costs about 1*s.* 9*d.* per square yard, and has a life of upwards of thirty years. In Derby these bricks last for twenty years, and can then be used again for other purposes; and generally they have been excessively durable when thoroughly vitrified; they are especially suitable for use in back-streets or narrow footpaths in the districts in which they are manufactured. They have, however, a multiplicity of joints, and the pavement cannot therefore be considered a sanitary one; they are difficult to bed level unless laid upon a foundation of concrete, which adds largely to the cost; they wear very slippery and unevenly, and unless the quality is of the best, the skin is soon rubbed off, showing a red interior which wears as rapidly as an ordinary building-brick. A thoroughly satisfactory pavement of this material is not easily obtainable; the appearance of the bricks is against them, and a brick pavement always feels "harsh" to the feet. A buff brick of an improved appearance has lately been introduced,

and is said to wear as well as the blue vitrified Staffordshire brick.

Granite Slab Pavement.—This is sometimes adopted, large granite slabs, 6 inches in thickness, being laid ; they are very useful when there are cellars underneath, or where heavy vehicular traffic is intended to cross the foot pavement. Granite is of course excessively durable, but it wears very slippery with traffic and must then be tooled or axed ; in process of time this wears it out, and its first cost is heavy.

This description of pavement can be laid with advantage in front of markets or similar buildings.

Artificial Asphalte Pavements.—The cost of obtaining natural rock asphalte from the mines, and the knowledge that it is composed of two very simple ingredients, limestone and bitumen, has led to a great number of artificial asphaltes being introduced, especially for foot pavements. "British Rock Asphalte" is a name by which many of the compositions are known ; "Beauchamp's Mendip Mountain Machine-made Granite Asphalte" is a high-sounding title ; "Prentice's Mineral Foreign Rock Asphalte" is another.

All these, and many more of the same description, are really what may be better and more correctly described as "tar concrete" or "tar paving," and consist of different modifications of the homely coal-tar and limestone.

So long ago as the year 1840, "Lord Stanhope's Composition" was well known : it was made as follows :

Three gallons of Stockholm tar, 2 bushels of well-dried chalk, 1 bushel of fine, sharp, clean sifted sand ; the whole being boiled in an iron caldron.

Tar paving is now made in many and various ways by different surveyors of towns, but the following hints upon the subject may be of some value. Either gravel or stone chippings must be carefully screened through sieves of $1\frac{1}{4}$ inch, $\frac{3}{4}$ of an inch, $\frac{1}{2}$ an inch, and $\frac{1}{4}$ of an inch gauge, and then heated on iron plates with fires burning underneath.

The gravel, or chippings, having been thoroughly dried and heated, the following ingredients are mixed together, boiled in iron cauldrons, and added whilst hot; 12 gallons of tar, ½ cwt. of pitch, and 2 gallons of creosote to about 1 ton of the screened materials. The composition when added to the gravel, or chippings, should spread easily and thoroughly over every particle of the stone. This now becomes tar-concrete, and can be laid in layers, the largest size gravel at the bottom, and so on up to the smallest size for the top layer, each layer as it is laid being well rolled with an iron roller of about 10 cwt.

In order to secure success with this description of pavement it is well to observe the following conditions :—The stone-chippings, or gravel, must be thoroughly heated so as to ensure perfect dryness, as then the composition will adhere firmly. It is better to keep the tarred materials a month or two before use, so as to be thoroughly soaked by the composition. Broken Kentish ragstone, or limestone chippings, make the best tar pavements, as too hard a material causes a bumpy path. The laying should, if possible, be carried out in the spring, or winter, if dry, as a hot sun draws the composition away from the stone on to the surface of the path. The foundation of the path must be dry, as water seriously affects the tar-concrete. When the last layer of the path has been completed it must be dusted over with fine grit, or stone dust, and this facing, accompanied by a thin "painting" with tar, should be repeated at least once every other year.

With regard to the cost of this description of pavement the following facts, compiled for a recent return upon the subject, may be interesting :—

At Banbury, the cost of tar-pavement is only 9*d.* a square yard, whilst at Hereford it is 3*s.* In Bath the cost is 1*s.* 9*d.*, and the footpaths last in good repair for twenty years; whilst in Burnley their life is only five years. In Darlington they

last for ten years, and are then re-topped at a cost of 3*d.* per square yard, their original price having been 2*s.* per square yard. In Doncaster, where the cost is 1*s.* 8*d.* per square yard, the paths wear from twenty to thirty years. In Harwich, the cost being 1*s.* 4*d.*, they last ten to twelve years, a coating of hot tar and sharp grit being put on the surface every year. In Ipswich the life is thirteen years; and in Peterborough, where the cost is only 1*s.* 3*d.* per square yard, the life is from fifteen to twenty years. In Scarborough the cost is 1*s.*, and the life ten to fifteen years; and in Windsor the cost is 2*s.*, and the life twenty years. In Streatham it is used in all new streets previous to being taken over by the local authorities, and some paths laid down in the year 1870 remained perfectly sound and good at the end of the year 1885. The disadvantages of tar-pavement are as follow:— It is dark in colour unless a very light-coloured stone chipping is used; it is apt to wear gritty or bumpy; it is rather difficult to repair. In very hot weather it sometimes becomes rather sticky or soft. Tar-pavement must only be reckoned as a substitute for ordinary gravelled footpaths. It must not be compared with paved or asphalted paths; but there can be no doubt that a pavement of this description for traffic that is not too heavy answers every requirement; for streets of greater traffic, genuine mastic asphalte should be used.

Before closing my remarks on artificial asphalte pavements, the following description of an American method may be interesting:—

On a dry foundation is placed a coat of rough clinkers from anthracite coal, or iron clinkers from a foundry, mixed with sand and tar in the proportions of 15 cubic feet of fine sifted ashes, 14½ cubic feet of pit sand, and 1½ cubic feet or 9 gallons of tar. This is laid about 3 to 4 inches thick and well rolled. Over this is placed a coating from 1 inch to 1½ inch thick, composed of 15 cubic feet of coarse sifted ashes, 15 cubic feet of clinkers, and 1½ cubic feet or 8 gallons

of tar. It must be then well rolled and sanded, care having been taken that the materials are thoroughly mixed.

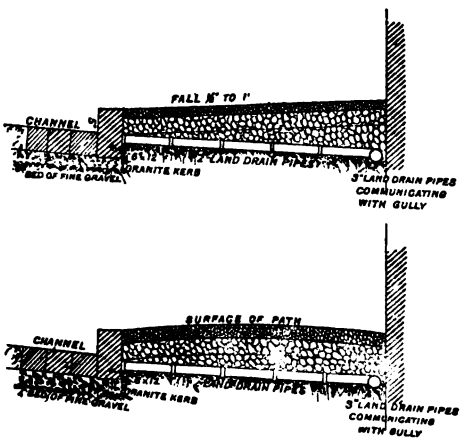
Gravel Footpaths.—Very little can be said upon this subject; such footpaths are only suitable for suburban districts, or opposite vacant land; they are uncomfortable to the pedestrian, and are either covered with loose stones and dust in dry weather, or with slippery mud in wet weather. In Chorley, screened furnace cinders are used instead of gravel, at a cost of 4*d.* per square yard, and the footpaths last for about eighteen months without repair. Chippings of Mendip rock, limestone, and even of granite, are sometimes substituted for gravel with good results, but these footpaths cannot be considered economical, as the material of which they are made is constantly being washed or kicked off the path; and it was to meet the unsatisfactory state of things arising from the "gravelled" path that tar-concrete was introduced with such beneficial results.

The same rules that apply to a macadamised roadway apply to a gravel footpath. They must be well "bottomed," and well drained and well rolled. Limestone or other stone chippings may with advantage be used with a pit gravel for constructing paths of this description, and a barrelled surface looks better and is more enduring than a hanging path. The following cross sections of footpaths will explain themselves better than any long description.

Gravel footpaths are sometimes tarred over when thoroughly consolidated. This must be done only when the weather is quite settled and fine, the least rain will spoil the whole operation; it consists in simply tarring over the surface of the footpath in the same manner that a gate or wall or any other substance would be tarred. The surface of the path must previously have been swept perfectly clean, and immediately the tarring is completed, fine stone dust must be sprinkled on its surface; the traffic should be diverted from it for a few hours, and it is then ready.

Care must be taken that the tar is not too thin in con-

sistency, and that the coat is not put on too thick. Treating a path in this manner saves gravel, which is washed or kicked off it if left with an ordinary surface; but a cold night, a light shower, or inferior tar will make the whole process abortive, and the path will be in a fearful mess in the winter.



For further information upon the subject of footpaths I refer my readers to a paper written by me and published in the Minutes of Proceedings of the Institution of Civil Engineers, vol. lxxxv. part iii.

CHAPTER XII.

KERBING AND CHANNELING, ETC.

FOR all footpaths, both urban and suburban, a kerb of some description is necessary to be fixed on the outside of the footpath, for the following reasons:

(1.) It acts as a sill against which the material of which the footpath is paved may butt.

(2.) It retains both the foundation and surface of the footpath.

(3.) It prevents vehicular traffic driving on to the footpath.

(4.) Whether there is a paved channel gutter or not, a kerb is necessary in order to finish the haunches of the roadway.

(5.) The appearance of a footpath without kerbing is very unsightly.

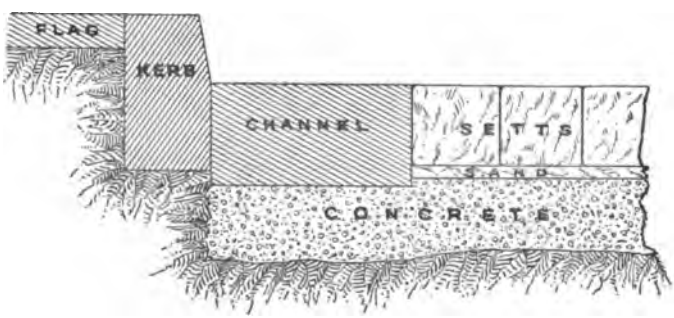
(6.) Unless a footpath is raised above the roadway it is liable to be flooded.

Many materials are used for kerb, of which granite being the best is generally used in streets where there is much traffic, as the kerb is often subjected to severe blows from the passing vehicular traffic, as well as a grinding action from the wheels of waggons and other heavy vehicles, especially on gradients where "hugging" the kerb acts as a drag or break. In such cases granite, although the most expensive in the first case, is certainly the most economical, and no other material should ever be used.

The dimensions of kerb vary considerably in different localities and according to the width of the footpaths, the wider the path the wider should be the kerb. It should however never be of less depth than 9 inches, nor narrower than 4 inches ; depth is necessary to prevent the kerb turning over towards the channel, gutter, or water table as it is sometimes termed, and the filling in on the gutter side must also be well rammed with a bar to prevent this. Kerb should never be in less lengths than 3 feet, and when 8 inches and broader, it is better that the top surface should be bevelled off to conform with the slope of the footpath, but in narrower kerbing such a practice is unnecessary, and if carried to an extreme may even be dangerous.

The kerb should be drafted about 1 inch along both top edges, and hammer dressed about 5 inches on the face, in addition to the whole surface of the top and for 3 inches at the back, in order that there may be a smooth surface visible against the channel gutter, and also for the flagging or other paving to butt fair against, besides giving a clean appearance to the aris of kerb both inside and out, in addition to this in streets of heavy traffic it is well to splay off the front face of the kerb in order to minimise the effect of the grinding action previously mentioned.

The following section of an 8-inch granite kerb will explain this :



The top surface should always be tooled or axed whenever it has worn smooth and slippery, as a slip from a kerbstone often causes a very bad fall to a pedestrian.

Setting kerb requires a very experienced hand, for as it is set dry great care must be shown, or it will sink, turn slightly over, or move even months after it has been set. In addition to this it is heavy stuff to handle, but unless the line is accurate both as regards level and contour, the appearance will be exceedingly bad. Of course the skillet line and boning rods are freely used in setting kerb, but even with these helps one mason will set kerb in a pleasing manner, whilst another, with even more care, does not seem able to make it appear graceful.

Deep and narrow kerb should be bedded on good clean river gravel, and beaten into its place with hard blows from a heavy wooden setting maul or beetle weighing not less than 50 lbs.

Broader and shallower kerb should be bedded on concrete.

In addition to granite, kerbing is also made of Endon or Yorkshire stone, limestone, and for brick pavements a kerb specially made of the same material is generally used. In France an L-shaped iron kerb is sometimes used, and kerbs made of artificial stone or concrete are frequently made in this country. It is also, though not often in this country, constructed of wood, old railway sleepers being used for the purpose. In the more rural districts grass sods are used with good effect for gravel paths.

It is difficult to estimate the cost of kerbing, as local questions must interfere, carriage of the material and value of labour entering so largely into the question.

Mr. Codrington* states that "A limestone kerb about 1 foot deep and 4 inches wide costs from *2s. 6d.* to *3s. 6d.* per lineal yard, and a channel 10 inches wide by 6 inches thick rather more.

* 'The Maintenance of Macadamised Roads,' by Thomas Codrington, p. 18.

"Granite kerbs 12 inches wide by 9 inches deep, 6*s.* 6*d.* to 7*s.* per yard run.

"Granite channel 12 inches wide by 6 inches deep, 4*s.* 6*d.* per lineal yard.

"A channel 12 inches wide, formed of granite cubes 4 inches by 7 inches, costs about the same."

I have found that granite kerb 6 by 12 inches could be fixed "*in situ*" at 3*s.* 3*d.* per yard run, and 8 by 12 inches at 4*s.* 6*d.* per lineal yard.

Granite channeling composed of 3 courses of granite pitchers 6 by 8 inches, costing 5*s.* 6*d.* per lineal yard.

Limestone channeling 15 inches in width by 3 inches in depth, costing 3*s.* per lineal yard.

A paved channel, gutter, or water table is of the greatest use to a roadway, besides adding greatly to its appearance. Without such a channel the haunches of a road become sadly damaged by the wash of the surface water, which is sometimes so extreme as to undermine the kerb and cause it to fall out.

These channel gutters are made of different materials for macadamised roads, granite setts laid in the direction of the gutter being the best. A channel gutter should not be less than 18 inches wide, so that if made with ordinary 3-inch setts, 6 courses will be necessary; they should be bedded on gravel and well grouted in with lime or cement grouting. Sometimes granite slabs 18 inches wide by 3 or 4 inches thick are used and make an excellent gutter; they are however liable to tip under heavy loads. Limestone slabs can also be used in roads of light traffic with advantage.

In streets paved with granite setts, wood blocks or asphalte, the same material is used for the channeling, the setts or blocks being however bedded in line with the channel instead of transversely as in the street itself.

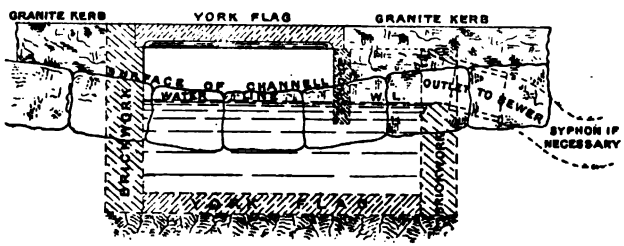
The channel gutter should take the slope of the roadway, and the granite kerb should show from 3 to 5 inches above

it. At paved crossings it is well to keep them level with the kerb so that pedestrians may step off the path on to the crossing without any drop; or if there is any water in them at such points, it is a good plan to let the edge of the crossing drop rather suddenly towards the kerb, so that the ordinary stride of the pedestrian carries him on to the level.

Gully gratings or buddle holes should be placed along the line of channel at such intervals as may be found necessary. A great number of different forms have been from time to time introduced for this purpose, the objects to be considered being:

(1.) Sufficient area to carry off all the water.

(2.) Not easily choked on surface by leaves or other debris.



(3.) Sufficiency of pit to retain all sand or road detritus, and prevent it being washed into the sewer.

(4.) The least possible obstruction to the traffic.

(5.) Constructed so that the pit may easily be cleaned out.

(6.) Trapped so as to prevent the escape of sewer gas.*

(7.) The drain from it should be easily freed of any obstruction.

What is called a "buddle hole," which is an opening under the kerb, has much to recommend it as giving a free unobstructed waterway, and at the same time avoiding the necessity of a grating in the street itself. The above

* In many towns the gully gratings are purposely in direct communication with the sewers, so as to act as ventilators; but this is a doubtful practice.

drawing will explain the general features of this "buddle hole."

A great number of different descriptions and forms of gully pits are shown in Mr. Baldwin Latham's excellent book on sanitary engineering, to which I refer my readers for any further information upon this subject.

CHAPTER XIII.

LIGHTING STREETS.

AT the time when I was writing the first edition of this book the question of lighting streets by electricity was attracting much attention; but I stated "that electric lighting will not easily be adopted in old cities and towns, where, in addition to the main streets being narrow and crooked, there are few large, open spaces suitable for intense lights, and there are numerous small courts and alleys which require lighting, and this for a long time to come will probably be effected with gas." I also quoted at length the following letter addressed to the Editor of the *Standard* newspaper:—

SIR,—At this time, when the question of lighting by means of electricity is receiving so much attention, and as Chesterfield is the only town in England whose lighting is done throughout by electricity, it may be interesting to your readers to know what our experience has been.

I need not detail the stages which led to our abandoning gas, and taking up the electric light after being in darkness some months. I may briefly state that, after going carefully into the question, we decided to adopt the system whose praise was in everyone's mouth a year ago, namely, "The Brush," and, though we were applied to by other companies, we placed the execution of the work in the hands of the one that we considered the most suitable—the Hammond Company. During the negotiations of the contract, Mr. Hammond particularly pressed us not to stipulate for incandescent lamps, as he acknowledged that their Company were not in a position to cope with incandescent lighting for public purposes. We, however, decided upon the town being lighted with the Lane-Fox Incandescent Lamps, as well as the Brush Arc Lights.

After waiting many weary months for the completion of the incandescent lighting, it is now, when declared by the contractors complete, in my opinion a decided failure. The Lane-Fox lamps, which have been supplied by the Brush Company, are most variable in their lighting power; whilst some are good, others only give a feeble light instead of a light equal to that of fifteen candles, as expected. The arc lights are doing good service in some of the large streets, but as a whole I think it has been fully demonstrated in a year's trial in Chesterfield, that the field for arc lighting is very limited indeed.

Though the tradesmen have been canvassed by the Hammond Company with

a view to introducing the arc lights into their shops and hotels, in not one single case has the light been adopted. Indeed, it is evident to us who have them under our eyes every night, that they are only fit for lighting works and large open spaces. The experience that has been thus gained at Chesterfield, at the present juncture must be of value to all towns intending to adopt the electric light, and is my reason for troubling you with this letter, although I believe the time will shortly come when lighting by electricity may be advantageously adopted, both for public and private purposes.

I am, Sir, your obedient servant,

GEO. EDWD. GEE.
Alderman of the Borough of Chesterfield.

HIGH STREET, CHESTERFIELD, *October* 10, 1882.

Subsequent events have confirmed this letter, and the words that I wrote nearly ten years ago; lighting streets by electricity has made very little progress since then; though, for indoor lighting with incandescent lamps great strides have been made.

In confirmation of these remarks I add the following extract from a leading article in the *Times*, which appeared in the issue of August 19th, 1891:—

"But it seems to us, nevertheless, that between gas and electricity in the lighting of streets, the main question is one of candle power only, and therefore virtually of cost. The lighting of houses is quite a different matter. Combustive illumination, whether of gas or oil, or even of wax candles, involves heat, dirt, vitiated atmosphere, and tarnished decorations. The incandescent illumination of electricity involves none of these drawbacks, except a very moderate degree of heat. Apart from its cost, therefore, it is almost an ideal mode of domestic and general indoor illumination. But all these advantages are thrown away in the open air, where the vitiation of the atmosphere is infinitesimal, the heat is imperceptible, and there are no decorations to tarnish. Besides, in street illumination the incandescent lamp cannot compete with the arc lamp, and the unshaded light of the arc lamp is too brilliant for ordinary use. It therefore becomes necessary largely to reduce its candle power, by means of opalescent

shades. The whole question seems to be reduced, therefore, to one of economy. We should be glad to know whether the effective candle power supplied by the twenty-six arc lamps in Queen Victoria Street could or could not be supplied at the same cost by means of gas, and quite as efficiently distributed. On this issue, as it seems to us, the comparison of gas and electricity as street illuminants must ultimately rest."

With reference to lighting streets, section 161 of the Public Health Act, 1875, enacts as follows:

"Any urban authority may contract with any person for the supply of gas or other means of lighting the streets, markets, and public buildings in their district, and may provide such lamps, lamp-posts, and other materials and apparatus, as they may think necessary for lighting the same. . . ." (38 and 39 Vic. c. 55, s. 161.)

I do not propose to entertain the question of lighting where the gas works are the property of the corporation, but only to give information that may be of use where a contract has to be entered into between the corporation and a company, and also to give some general information upon this subject which may be of interest to the surveyor. Most lighting contracts are based nearly always upon the length of time at which the public lamps are to be kept lighted, and may be summarised as follows:

First, where the public lamps are lighted from sunset to sunrise every night throughout the year; this averages 12 hours per diem, or about 4000 hours per annum.

This is exceeded in some instances, the highest being in the City of London, where the hours of lighting amount to 4300. The average of the towns of the United Kingdom, with a population of 100,000 and upwards, amounts to 3648 hours.

The following table has been carefully prepared, and provides for an annual lamp-light of 3808 hours, and is shown graphically on the diagram on page 165.

Time Table for Lighting and Extinguishing the Public Gas Lamps.

From	To	All to be Lighted by	Begin to Extinguish at	Hours per Night.	No. of Nights.	Total Hours Lighted.
		H. M.	H. M.	H. M.		H. M.
January 1	January 8	5 3	7 8	15 5	8	120 40
,, 9	,, 15	5 13	7 4	14 51	7	103 57
,, 16	,, 23	5 24	6 58	14 34	8	116 32
,, 24	,, 31	5 38	6 48	14 10	8	113 20
February 1	February 7	5 51	6 38	13 47	7	96 29
,, 8	,, 14	6 5	6 24	13 19	7	93 13
,, 15	,, 21	6 16	6 10	12 54	7	90 18
,, 22	,, 28	6 29	5 56	12 27	7	87 9
March 1	March 8	6 43	5 41	11 58	8	95 44
,, 9	,, 15	6 57	5 23	11 26	7	80 2
,, 16	,, 23	7 9	5 7	10 58	8	87 44
,, 24	,, 31	7 22	4 49	10 27	8	83 36
April 1	April 8	7 35	4 30	9 55	8	79 20
,, 9	,, 15	7 49	4 13	9 24	7	65 48
,, 16	,, 23	8 0	3 51	8 51	8	70 48
,, 24	,, 30	8 14	3 30	8 16	7	57 52
May 1	May 8	8 26	3 6	7 40	8	61 20
,, 9	,, 15	8 45	2 45	7 0	7	49 0
,, 16	,, 23	8 57	2 27	6 30	8	52 0
,, 24	,, 31	9 12	2 12	6 0	8	48 0
June 1	June 8	9 26	1 57	5 31	8	44 8
,, 9	,, 15	9 42	1 47	5 5	7	35 35
,, 16	,, 23	9 55	1 43	4 48	8	38 24
,, 24	,, 30	10 2	1 51	4 49	7	33 43
Total for Six Months ending June 30th						1,804 42
July 1	July 8	10 2	2 5	5 3	8	40 24
,, 9	,, 15	9 50	2 18	5 28	7	38 16
,, 16	,, 23	9 35	2 30	5 55	8	47 20
,, 24	,, 31	9 21	2 42	6 21	8	50 48
August 1	August 8	9 0	2 59	6 59	8	55 52
,, 9	,, 15	8 40	3 16	7 36	7	53 12
,, 16	,, 23	8 22	3 33	8 11	8	65 28
,, 24	,, 31	8 7	3 48	8 41	8	69 28
September 1	September 8	7 52	4 4	9 12	8	73 36
,, 9	,, 15	7 30	4 20	9 50	7	68 50
,, 16	,, 23	7 7	4 37	10 30	8	84 0
,, 24	,, 30	6 48	4 52	11 4	7	77 28
October 1	October 8	6 30	5 7	11 37	8	92 56
,, 9	,, 15	6 12	5 21	12 9	7	85 3
,, 16	,, 23	5 57	5 33	12 36	8	100 48
,, 24	,, 31	5 41	5 47	13 6	8	104 48
November 1	November 8	5 26	6 1	13 35	8	108 40
,, 9	,, 15	5 13	6 15	14 2	7	98 14
,, 16	,, 23	5 4	6 27	14 23	8	115 4
,, 24	,, 30	4 55	6 40	14 45	7	103 15
December 1	December 8	4 51	6 50	14 59	8	119 52
,, 9	,, 15	4 49	6 59	15 10	7	106 10
,, 16	,, 23	4 50	7 5	15 15	8	122 0
,, 24	,, 31	4 54	7 8	15 14	8	121 52
Total for Six Months ending December 31st ..						2,003 24

Total Number of Hours Lighted during Year .. .. 3,808.

Note.—The Lighting of the Lamps to be commenced each evening one hour before the time specified for completion.

Under the above table the whole of the lamps are lighted within one hour of sunset from the beginning of January to the end of April, and then, taking advantage of the twilight, the time is gradually extended to one hour and three-quarters at Midsummer, from which point it gradually decreases in the same ratio to the end of September, where it is brought back to one hour after sunset, which position it maintains to the end of December.

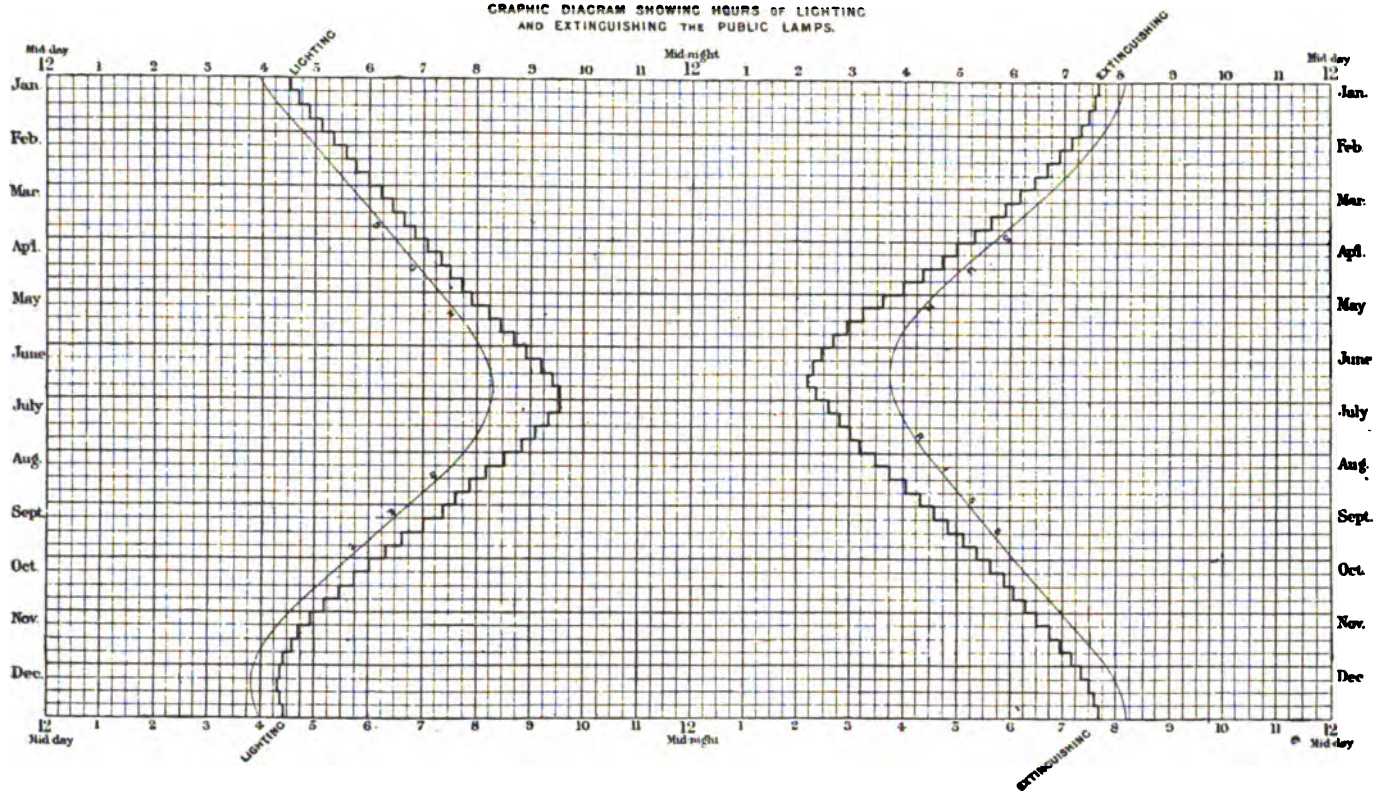
The graphic diagram on the opposite page will more fully explain this description.

In this diagram the vertical lines represent the hours and quarters, and the horizontal lines the months and weeks; the outer curves indicate the rising and setting of the sun, and the inner stepped curves represent the mean hours of lighting and extinguishing the lamps.

Another method sometimes adopted by economical local authorities is that by which the public lamps are not lighted on the nights of full moon, nor for two or three nights before and after this period; the rest of the year they are lighted at sunset.

A third method is somewhat similar to the preceding, except that the public lamps are not lighted during the five nights of full moon, the night after they are lighted for one hour and extinguished on the rising of the moon; this lighting increases from night to night about three-quarters of an hour until the moon has entirely disappeared, when the lamps are lighted during the whole of the night for five consecutive nights. Then again, on the appearance of the new moon the lamps are extinguished the first night for about an hour whilst the moon is visible, and this extension increases nightly about three quarters of an hour according as the moon appears until the period of full moon, the intention being to profit by every hour of the moon's light.

By this arrangement the lighting is about 2000 hours per annum, instead of 4000 hours, when it is continued throughout the night during the whole of the year.


GRAPHIC DIAGRAM SHOWING HOURS OF LIGHTING
AND EXTINGUISHING THE PUBLIC LAMPS.
Mid day
Mid night
LIGHTING
EXTINGUISHING
Jan.
Feb.
Mar.
Apl.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.

Under this arrangement it must not be forgotten that the nights of full moon are occasionally of the darkest description, and therefore, districts are sometimes left in complete darkness for several nights together. Where this method is adopted the following table may be of some service :—

TABLE OF THE MOON'S RISING AND SETTING.

At	4	days old	the moon	sets about	10 o'clock P.M.
,,	5	,,	,,	,, ,,	11 ,, ,,
,,	6	,,	,,	,, ,,	12 midnight.
,,	7	,,	,,	,, ,,	1 A.M.
,,	15	,,	,,	rises ,,	6 P.M.
,,	16	,,	,,	,, ,,	7½ ,,
,,	17	,,	,,	,, ,,	8½ ,,
,,	18	,,	,,	,, ,,	10 ,,
,,	19	,,	,,	,, ,,	11 ,,
,,	20	,,	,,	,, ,,	12 ,,

It may also be of some use to know that the length of the day may be easily found by doubling the hour of sunset, and the length of the night may similarly be ascertained by doubling the hour of sunrise. It may be also interesting to know that the hour of sunset can always be ascertained if the hour of sunrise is known by simply deducting the hour of sunrise from the number 12. Thus, if the sun rose at 7 A.M., it would set at 5 P.M. ; if at 6.40, it would set at 5.20, and so on.

In some districts the lamps are not lighted at all during the summer months ; and in others the public lamps are extinguished at midnight all the year round, if not for the whole, for some portions of the district, it being assumed that, all respectable citizens being in bed, no light is required.

In some cases every other lamp only is lighted in the summer months, and many other similar variations for the sake of economy may be practised.

Of all the methods which I have enumerated as modifications of the first, it is, I think, evident that the first is the most satisfactory to the inhabitants, the urban authority, their officers, and the gas company ; it is the least likely to

introduce disputes; and although something may be saved by adopting the more parsimonious methods enumerated, it is found in practice that the first is the best. Of course with the "all night" principle a saving can, and is, effected by reducing the quantity of gas consumed by the more powerful lamps at midnight, and it is possible that this practice might be more fully developed and extended by applying it to all public street lighting, if not for the whole, to a portion of the district, as it is evident that the same amount of lighting which is necessary for the early hours of darkness is not so necessary as the night progresses, and the majority of the citizens are in their beds. It is, however, of course necessary that the lighting should be sufficient for police and other purposes, and safety must not be sacrificed to economy.

The following suggestions for drawing up an agreement with the gas company to light the public street lamps for any length of time, may be of some use:—

Hints for a Contract with a Gas Company.

The company to provide a sufficient supply of gas of the full illuminating power and quality as provided by their Act.

Payment to be at so much per lamp, or per 1000 cubic feet consumed, or at per hour, or whatever may be determined on.

Payment to be made by urban authority for lighting, extinguishing, cleaning, repairing, etc., as may be agreed, such payments to be made quarterly, or at such times as may be agreed upon.

The hours or times throughout the year during which the lamps shall be lighted to be determined by a table, every lamp to be fully lighted within one hour of the time named, and not extinguished before that named for extinguishing. The consumption of the gas to be regulated and determined by Sugg's or Borradaile's street lamp governors, or such other mode as is agreed upon.

The company to keep the governors, burners, and all pipes, valves, etc., in repair free of charge, and, if thought advisable, the lanterns, at a fixed sum per lamp per annum.

The company to light and extinguish, and keep all lanterns clean, and all pipes, valves, etc., in repair.

The company to keep the lamp-posts, etc., properly painted and in repair after they are fixed by or to the order of the urban authority. Lamps may be shifted or fresh lamps erected by the urban authority, on their paying the cost.*

Section 24 of the Gasworks Clauses Act, 1847, provides that "the undertakers shall supply gas to any public lamps within the distance of fifty yards from any of the mains of the undertakers . . . ;" and something of this kind must be incorporated in the contract, though of course this limit may be varied with the consent of the local authority and the undertakers.

A certain pressure of gas must be maintained, to be ascertained by water gauges fixed at certain public places, or at such points as may be determined, or by casual experiment.

Any lamps burning under size or out, shall be immediately attended to by the company. A deduction in payment for gas by the urban authority to be made if neglect can be proved. An arbitration clause is necessary for this or other matters that may be disputed, and also a clause for determining the agreement upon notice being given.†

* Clause 13 of the Gasworks Clauses Act, 1847, empowers gas companies to enter into contracts, amongst other things, "for providing such commissioners, trustees, or persons with lamps, lamp-posts, burners, and pipes for such purposes, and for the repairs thereof in such manner and upon such terms as shall be agreed upon." It is therefore competent for any local authority to enter into a contract with the gas company to provide all the necessary apparatus and labour for street-lighting purposes, and in a large number of towns the lighting contract is arranged in this way.

† Section 36 of the Gasworks Clauses Act, 1871, provides . . . "Whenever the undertakers neglect or refuse to supply gas as by this Act required to all or any of the public lamps, in accordance with the provisions of this Act, they shall be liable to a penalty not exceeding 40*s.* for each default." As to any difference

In supplying gas to the public lamps by meter, either wet or dry meters may be employed, and these are fixed either in the lamp-posts themselves or under the footpath. Sometimes each lamp has a separate meter, but in the generality of cases one meter fixed to a lamp gives the average of gas consumed by ten or a dozen of its fellows at the same level, and in the same neighbourhood. In the metropolis and elsewhere, where sudden fogs make it necessary to light the public street lamps at all sorts of hours, this system has its advantages, but the difficulties arising from it may be enumerated as follows:

(1.) The liability of the meters to get out of repair, especially in times of severe frost, or by vibration of traffic.

(2.) The first cost of providing and fixing the meters, and subsequent cost of repairs.

(3.) The trouble and cost of inspection and keeping the accounts.

And it is found that by employing either Borradaile's, Sugg's, or other regulators, the consumption of the gas can be readily adjusted to consume from 3 to 6 cubic feet per hour, according to the requirements of the situation of the lamp. The Surveyor of Folkestone says: "Sugg's self-acting regulator is used, adjusted as nearly as may be practicable to consume 4 feet per hour, and so very satisfactory is this apparatus that for the last two years, after burning 7294 hours, it is found by the average meter to have consumed 29,227 feet, as against 29,176 feet as per regulator, being only 51 feet in excess of that which the apparatus is adjusted to consume." *Vide* Ellice Clarke on "Gas in Public Streets," Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors, vol. ii. p. 193.

Mr. Strachan, the then Surveyor of Chelsea, confirmed

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which may arise between the undertakers and any local authority, it "shall be from time to time settled by arbitration in manner provided by the Companies Clauses Consolidation Act, 1845, with respect to the settlement of disputes by arbitration"—(Gasworks Clauses Act, 1847, s. 27).

this opinion of the reliability of regulators in a paper he read before the same Association, and he proved that a good type of gas regulator for street lamps was equal in accuracy to a meter, and that consequently nothing was to be gained by the use of the latter. *Vide* Strachan on the "Average Meter System," *Ibid.*, vol. xiv. p. 336.

The record of eleven years' work with the average meter system at Kensington also showed that when the regulators were set at 4·5 cubic feet, the average consumption was 4·503, which is ample evidence that there is no variation between well-constructed gas meters and accurately-adjusted gas regulators.

Lamp-posts and lanterns are of innumerable sizes, shapes, and patterns, but the following hints in connection with them may be of some service :—

The lamp must not only be ornamental by day, but useful by night.

The light must not be placed either too high or too low. No definite rules can be made for this height, but in each locality the surveyor must decide for himself by careful observation and experiment.

The post must not be too clumsy so as to interfere with the pedestrian traffic, nor too fragile so as to be easily broken if driven against. Bracket lamps have advantages in these respects, and are cheaper; they also throw very little downward shadow, though with columns this can and should be also avoided by arranging the top of the lantern so that the opal glass of the roof shall deflect the light on each side of the column, so that there is little or no shadow of any kind.*

The lantern should be made with the lightest possible amount of metal frame compatible with sufficient strength, the angle bars should be very narrow to avoid shadow, trap

* Bracket lamps may not be fixed by an urban authority to houses within their district without the previous consent of the owners of such houses. *Vide* "Fitzgerald's Public Health Act," third edition, p. 182.

doors of perforated zinc or glass should be provided at the bottom for the admission of the torch, and a good outlet at the top is essential for the escape of the heated air, so constructed as to prevent any down draught, that most fruitful cause of the blacking of lamps. Flat glass is much cheaper and easier of repair than curved. The top of the lantern should be glazed with opal glass, otherwise a large percentage of the light is lost; this is very observable on approaching a large city, by the glare which is thrown upwards. Some hundreds of different patterns of lanterns for street lamps have been designed from time to time, and it is not necessary, nor have I space, to describe them. Their essential requirements are :—

(1.) The proper arrangement of the burner with regard to the angle of the top of the lantern and the desired area of the diffusion of the light.

(2.) The provision of efficient ventilation without interference with the tranquility of the flame.

(3.) Economy of construction compatible with strength, durability, and appearance.

The burners should have steatite tips, and be of varying size, to suit the requirements of the locality, and the quality of the gas. This is an important consideration, as it is well known that a burner suitable for 14-candle gas will not economically consume 16-candle gas, and so on. The illuminating power of a given sample of gas may easily be depreciated to the extent of from 20 to 25 per cent. by the use of an unsuitable burner. While referring to the most suitable form of burner, I may point out that low-pressure governor burners are essential, as for the economical combustion of gas the pressure on the burner must be constant. The following table graphically illustrates this assertion. In the first case the burner is an ordinary ungoverned one of the high-pressure type, and though often termed a regulating burner, is simply packed with wool, sponge, or other material, to retard the flow of gas, but is not automatic in any sense. It will be observed

in the table that with this burner every increase of pressure is accompanied with an increase of consumption, and a decreased yield of light, but in the case of the governor burner, through which the gas is consumed at a low and constant pressure, it will be noted that the regulation is of a truly automatic character, for while the burner is tested through the same variations of pressure as in the preceding case, the rate of consumption and illuminating value remain unaffected. The variations of pressure shown in the table are those commonly occurring in most districts, and are often exceeded, and therefore the enormous importance of using governor burners of reliable make will be apparent.

TABLE.

Description of Burner.	Pressure.	Consumption.	Illuminating Power per Foot of Gas.	Decrease per Cent.
	Inches.	Cubic Feet.	Candles.	
Ordinary ungoverned burner, No. 4 . .	0·5	3·9	3·0	..
	1·0	5·6	2·4	20·0
	1·5	7·0	1·9	36·7
	2·0	8·45	1·5	50·0
	2·5	9·6	1·35	55·0
	3·0	10·5	1·11	63·0
Governor burner rated at 5 cubic feet per hour	0·5	5·0	4·2	Nil.
	1·0	5·0	4·2	,,
	1·5	5·0	4·2	,,
	2·0	5·0	4·2	,,
	2·5	5·0	4·2	,,
	3·0	5·0	4·2	,,

The above experiments were made with 21-candle gas measured by "The Metropolitan Gas Referee's" Standard Flatflame Burner. While referring to "The Referees," it may be of interest to note that, following their appointment in 1869, they made the most exhaustive experiments with the gas burners commonly in use in the Metropolis, and calculated that over £500,000 was annually wasted through the use of bad and unsuitable burners. This related to a period twenty-two years ago, when the gas consumption in the Metropolis was very much less than it is to-day.

The regulators which I have previously mentioned must be kept in good repair, the work being carried out by the authority which owns them (the local authority or the Gas Company), the other having access to them at all times either for examination or testing. A lever tap is indispensable with the torch for lighting, as well as the trap door or opening in the lantern through which the torch is inserted.

Each public lamp-post should be legibly numbered, and the surveyor should keep a register in his office of all the public lamps in his town.

In order to determine the distance apart of the public lamps in a street, it must be remembered that the intensity of light is directly proportional to the illuminating power of the light, and inversely proportional to the square of the distance of the light, if unreflected. For instance, the illumination of any point between lamps may be arrived at by adding all the quotients obtained by dividing the illuminating power in standard sperm candles of each lamp, by the square of its distance in yards from the point.

Thus a point midway between two lamps of 15 candles each, 20 yards apart, would be reckoned thus :—

$$X = \frac{15}{100} + \frac{15}{100} = \cdot 30.$$

In this country, the rule has generally been adopted that public street lamps burning 5 cubic feet per hour of 15-candle gas should not be placed at a greater distance than 70 yards apart, the average distance in most English towns being about 50 yards.

Upon this point, and as an instance of one of the best examples of street lighting by gas in this country, Lime Street, Liverpool, may be quoted.

It is 480 yards in length and 30 in width. It is lighted by 34 lamps of 120 candle-power each, placed on 12-foot columns on the side-walks. There are also ten lamps of 200 candle-

power placed on 14-foot columns fixed in the roadway. The lamps were placed in such a way as to ensure the greatest uniformity of light throughout the street, the minimum average luminosity at the least point of light, as carefully measured by a travelling photometer, being 3·407 candles. This is of course considerably in excess of ordinary requirements, but is an interesting instance of what can be done in street lighting with gas, as it renders it possible for a person to walk through this street and at any point of it be able to read with ease ordinary newspaper type. Upon this question the foregoing table of returns from 25 important towns will no doubt be interesting.

The competition which was started by electricity a few years ago, although so far the electric lighting companies have devoted themselves more to private than to public lighting, gave a great impetus to gas lighting.

A large number of improved street gas-lamp burners and lanterns were invented, some of which have been brought into general use. Many of them are great improvements upon the ordinary type of lantern in connection with the air-supply and the construction and angle of the roof, etc.

It has also been ascertained that by fixing clusters of burners together the light of one flame is considerably increased by the proximity of others. As I have already stated, it is a common practice with lamps of high power to reduce the consumption at midnight to that of the rate of the ordinary lamp (about 5 cubic feet per hour), and it is found that by the adoption of this method the lighting between sunset and midnight can be increased three or fourfold at about twice the ordinary cost.

In the first edition of this book I gave some information upon the question of lighting streets by electricity, but the subject has now grown to such large proportions that it would be impossible, in a book of this description, to condense

any particulars which could be of service to the Town Surveyor.

I will content myself, therefore, in closing this chapter, to repeat what I then said, viz. :—There is no doubt that the acme of all artificial lighting is the prolongation of the light of day, and whether this is proposed to be effected by electricity or gas, it should be the goal aimed at by all who make this question their study.

CHAPTER XIV.

STREET NAMING AND NUMBERING.

IT was not until the commencement of the present century that inconvenience was apparently felt from the want of any distinguishing names of streets, or numbers to houses, either in London or provincial towns; the first Act of Parliament on the subject being one passed in the year 1819, which gave powers to vestries and district boards to put up the names of streets, and even then for some considerable period afterwards houses or premises were not marked with numbers, but with distinguishing trade signs or names.

The Towns Improvement Clauses Act, 1847, however, contains the following clauses, which are incorporated with the Public Health Act, 1875, by the 160th section of that Act:

"The commissioners shall from time to time cause the houses and buildings in all or any of the streets* to be marked with numbers as they think fit, and shall cause to be put up or painted on a conspicuous part of some house, building, or place, at or near each end, corner, or entrance of every such street, the name by which such street is to be known; and every person who destroys, pulls down, or defaces any such number or name, or puts up any number or name different from the number or name put up by the commissioners, shall be liable to a penalty not exceeding 40*s.* for every such offence" (10 & 11 Vic. c. 34, sec. 64).

* "Street" includes any highway (not being a turnpike road), and any public bridge (not being a county bridge), and any road, lane, footway, square, court, alley, or passage, whether a thoroughfare or not (38 & 39 Vic. c. 55, s. 4). There seems to be some doubt, however, whether "the commissioners" can alter the name of any street without the concurrence of the owners of the properties abutting on such street.

"The occupiers of houses and other buildings in the streets shall mark their houses with such numbers as the commissioners approve of, and shall renew such numbers as often as they become obliterated or defaced; and every such occupier who fails within one week after notice for that purpose from the commissioners to mark his house with a number approved of by the commissioners, or to renew such number when obliterated, shall be liable to a penalty not exceeding 40*s.*; and the commissioners shall cause such numbers to be marked or to be renewed as the case may require, and the expense thereof shall be repaid to them by such occupier, and shall be recoverable as damages" (10 & 11 Vic. c. 34, s. 65).

Some difference even now exists as to the manner in which streets are named, there being considerable diversity in the sizes, colours, and materials of the name plates, as well as in the spaces allowed for the letters. The following list is given to show how this diversity existed in the metropolis even so late as the year 1870.

Table taken from a "Memorandum by the Superintending Architect of the Metropolitan Board of Works, relative to the enforcement of the Law regulating the naming of Streets and numbering of Houses in the Metropolis" (1871):

	Parish A.	Parish B.
Names on houses at corners of streets ..	237	281
,, on piers of railings	24	36
,, on iron plates	6	44
,, on wooden boards	18	36
,, on enamelled plates	1	2
,, impressed in terra cotta	2	3
,, in cement letters	14	9
,, in Minton's china letters	2	1
,, engraved on stone	5	13
,, on porcelain plates	1	1
,, with raised letters on iron girder ..	1	..
,, on board on posts	..	11
,, on zinc	..	2

And to this table are added the words, "Some names are completely hidden by vines; names given for 'streets' are put up

as 'roads.'" Since this table was prepared, however, the confusion has been rectified by the energetic action of the Metropolitan Board of Works, and subsequently by the London County Council.

It is no doubt essential that for postal, telegraphic, and social reasons there should be uniformity in the manner in which the naming and numbering of streets is carried out, and the following particulars and suggestions may be of use.

Names of streets should be marked up in such a manner as to be legible both by day and lamp-light, and the materials of which the name-plates are composed should be of sufficient strength to prevent any damage accruing to them from stone-throwing or other wilful or accidental injury, or from the action of changes of temperature or climatic influences of any kind, and the following list is given descriptive of some of the modern methods of effecting this:

Minton's China Tiles.—These are white glazed china tiles 6 inches square, on which either blue or black letters are burnt in, one letter on each tile (except in the case of St., which is on one tile); they are fixed by chasing them into walls of buildings, and setting them in cement. They are the best description of name-plate with which I am acquainted, their cost being only *7d.* each, with the additional advantages of being not easily broken; they can be removed and re-used with facility, weather has no effect upon them, and they require no attention whatever after they are once fixed.

Cast-iron Plates with Embossed Letters.—These are generally painted with a white ground and black letters; they are liable to become broken, and as they are fixed with screws, these rust through in course of time, when the plate may suddenly fall in a dangerous manner into the street; another disadvantage is that they require to be painted about once every three years.

Painted Names on Walls of Buildings.—This method

requires no special mention ; it is an economical plan, and is more adopted than any other, but the letters must be painted every three years at least, and they are apt to be defaced if the premises are painted by the owner or occupier.

Enamelled Iron Plates.—These look very well, but they are apt to get loose, and a blow from a stone will shiver them.

Wooden or Metal Figures cut out and fastened on to Boards or against Walls.—The same objection holds good with this method as with others of the same description ; the fastenings fail in time, and the name disappears.

Enamelled Glass Tablets in Street Lamps.—This is an excellent method, of recent introduction, and has many advantages. The name can be seen very plainly either by day or night, no private premises have to be interfered with in fixing them, a uniformity of position or "where to look" for the name of the street is secured, and there is no limit to the number of times the name may be repeated.*

Where the names of streets are placed against buildings, the letters which compose the name should not be less than 4 inches in height by 2 inches in breadth, with a space between each letter of not less than 1 inch ; a light colour should always, where practicable, be used for the background, and black or blue for the letters. One great objection to painted letters is that they must be frequently repainted, and in order to do this, ladders have to be raised against the building, which the occupiers naturally object to without previous notice ; it is always very annoying to any citizen to have the head of a painter appearing outside his bed-room window at any time, and more especially at an inconvenient hour in the morning.

In selecting names for streets it is very important that they should not be duplicated in a town, and also that there should be some sense in their nomenclature ; generally some local

* The law apparently gives the Sanitary Authority power to fix names of streets against any premises they may choose, without first applying for or obtaining any consent from either the occupier or owner of such premises. (*Vide* 10 & 11 Vic. c. 34, s. 64.)

association can be found with a family or historical name which is suitable for the street. Nothing is more ridiculous than to see such names as Bath Street or York Road given to streets which have as much association with such places as with Jericho.

The street having been properly and conspicuously named, the next point to consider is that of the manner in which it shall be numbered, there being three methods in vogue by which this can be effected.

(1.) By allotting even numbers on one side of the street and odd numbers on the other side.

(2.) By allotting consecutive numbers up one side of the street and down the other side.

(3.) By allotting corresponding numbers to both sides of the street which are distinguished by a prefix of north and south, or east and west, as the case my require.

The first is by far the best method to pursue, for the following reasons:

If the street is ever extended after being numbered, the sequence is in no way disturbed. By this method any house can be more easily found, as on reference to a directory it will at once be seen at which end of the street it is situated. If the second method had been adopted this would be impossible except for the first few numbers, and where a street is of considerable length, with branch streets running into it, this is of the greatest importance. It is the best method also for the Post-Office officials, as it facilitates the district sorting of the letters.

Giving each side of the street distinctive prefixes to its name, such as north and south, &c., is evidently a bad plan, and leads to much confusion.

In allotting numbers to premises in a street, if it has been already numbered care should be taken to disturb existing numbers as little as possible, for an altered number involves considerable expense as well as inconvenience to the occupier

of business or trade premises, owing to the necessity of altering billheads, letter-paper, &c., and sometimes even considerable trouble and expense in order to secure the validity of the title.

Avoid numbering from right to left, and take care to allot sufficient numbers to vacant spaces which may eventually be built upon; and to do this the length of frontage may be divided into such lengths as (in the surveyor's judgment) will represent the new frontages. In any case it is better to have too many numbers in a street than too few, and large premises, and any public or other buildings, which may be removed, and other buildings substituted, should have numbers allotted to them, although it will not be necessary to serve the notices to have them affixed. Most large shops prefer to have more than one number, although I have heard the rather far-fetched contention urged, that more than one number means extra rating.

Considerable care must be exercised to ensure that no separate premises are passed over in allotting the numbers, often only a door or side passage denoting the existence of another claimant for a number. Nothing looks worse in a freshly numbered street than to see such numbers as 37A or 96½ placed upon premises that should have had a distinct numeral, and thus showing that they must have been left out.

The manner in which streets are numbered is generally as follows:

The town surveyor or one of his assistants walks through the street, and with a piece of chalk legibly marks each house with its correct number, taking care to observe the precautions I have enumerated; having done this throughout its entire length, these numbers must be entered in a book with the name of the occupier written opposite to the number. Upon returning to the office the surveyor must then fill up and serve the necessary notice upon each of these occupiers, the following being given as a specimen of such notice:

Urban Sanitary Authority for the

TOWN SURVEYOR'S OFFICE, 189 .

I beg leave to give you notice, that the Town Council of , as the Urban Sanitary Authority, have approved of the number for the house in your occupation, in .

You are therefore required, within one week from the date of this notice [to obliterate the present number, and]* to mark the said house with the number so approved of, and to renew the same from time to time in the case of its becoming obliterated.

A penalty of 40*s.* will be incurred in the event of default in compliance with this notice.

I am,

Your obedient Servant,

Town Surveyor.

*To*_____

*No.*_____

* If the premises have no existing number, these words can be left out.

In the event of the old number with which any premises were marked not being obliterated by the occupier, the following notice may be served:

Urban Sanitary Authority for the

TOWN SURVEYOR'S OFFICE, 189 .

It has been reported to the Town Council that you have neglected to obliterate the old number of your premises, No. Street, after receiving notice of a new number being allotted to such premises by the Town Council, whereby you have incurred a penalty of 40*s.*

The duplication of numbers in the same street was found

to be the occasion of so much inconvenience, that the Council were obliged to re-number the street in question, and it is manifest that if a number allotted to another house is retained by you, the inconvenience sought to be removed will still remain.

I am therefore instructed to inform you, that unless the old number of your premises is obliterated within seven days from the date of this notice, proceedings will be taken against you for the recovery of the penalty incurred.

Yours faithfully,

Town Surveyor.

Of course, if nothing is done after service of this second notice, it only remains to summon the offender as provided by the sections of the Act, which I have given in the early part of this chapter.

In some towns all this trouble is avoided by a local Act conferring powers on the Corporation to fix street numbers to premises by means of the staff in their employment.

CHAPTER XV.

BREAKING UP STREETS.

IN nearly every city and town of the United Kingdom, except those where the gas and water undertakings are the property of the urban authority, the town surveyor is constantly annoyed by having some portions of his streets broken up and greatly damaged by the action of the gas or water companies of the district, and latterly by the Electric Supply Companies.

With regard to the great and lasting character of the damage caused to the street by this disturbance of its surface, I shall have something to say in this chapter, but it is first necessary to see what legal powers the companies have to break up the streets, and what powers the surveyor has to enforce the work being properly carried out.*

It will be found that the sections bearing upon this point are almost precisely similar in their wording in the following Acts:

"The Gas Works Clauses Act, 1847" (10 & 11 Vic. c. 15).

"The Water Works Clauses Act, 1847" (10 & 11 Vic. c. 17).

"The Electric Lighting Act, 1882" (45 & 46 Vic. c. 56.)

But with regard to the powers of the Government to lay telegraph and telephone wires, &c., the clauses are different, and are contained in,

"The Telegraphs Act, 1863" (26 & 27 Vic. c. 112).

* In some towns protective clauses in Local Acts have been obtained by the Local Authorities dealing with the conditions under which any undertaking shall be allowed to interfere with the streets and provide for all the necessary work of opening and reinstatement being carried out by the Local Authority at the sole cost and charges of the persons promoting the undertaking.

As the clauses on this subject of "The Water Works Clauses Act" are those which are incorporated with the Public Health Act, 1875, I shall select the sections from that Act, the first of importance being as follows:

"The undertakers, under such superintendence as is hereinafter specified, may open and break up the soil and pavement of the several streets and bridges within the limits of the special Act, and may open and break up any sewers, drains, or tunnels, within or under such streets or bridges, and lay down and place within the same limits pipes, conduits, service pipes, and other works, and engines, and from time to time repair, alter, or remove the same, and for the purposes aforesaid remove and use all earth and materials in and under such streets and bridges, and do all other acts which the undertakers shall from time to time deem necessary for supplying *water* * to the inhabitants of the district included within the said limits; doing as little damage as can be† in the execution of the powers hereby or by the special Act granted, and making compensation for any damage which may be done in the execution of such powers" (10 & 11 Vic. c. 17, s. 28).

The next clause deals only with the powers of laying pipes, &c., in private property, and here it will be well to remark, that if the water undertaking is in the hands of the urban authority they have much more power of entry for these purposes than companies possess (*Vide* ss. 16, 18, 32, and 54, 38 & 39 Vic. c. 55), but this is a matter which does not affect the questions dealt with in this chapter.

The next clause is upon the subject of giving the necessary notices, and is as follows:

"Before the undertakers‡ open or break up any street

* Or gas or electricity, as the case may be.

† These words apply only to the manner of doing the work, not to alternative ways of doing it. (*Vide* "Fitzgerald's Public Health and Local Government Act, 1875," 3rd edition, p. 45.)

‡ In the "Electric Lighting Act, 1882," the words "proceed to" have been inserted before the word "open," which is an obvious improvement.

bridge, sewer, drain, or tunnel, they shall give to the persons under whose control or management the same may be, or to their clerk, surveyor, or other officer, notice in writing of their intention to open or break up the same, not less than three clear days before beginning such work, except in cases of emergency arising from defects in any of the pipes or other works, and then so soon as is possible after the beginning of the work or the necessity for the same shall have arisen" (10 & 11 Vic. c. 17, s. 30).

The next clause is of great importance, as it gives the surveyor the necessary powers to dictate the manner in which the interference with his streets is to be conducted.

"No such street, bridge, sewer, drain, or tunnel shall, except in the cases of emergency aforesaid, be opened or broken up except under the superintendence of the persons having the control or management thereof, or of their officer, and according to such plan* as shall be approved of by such persons or their officer, or in case of any difference respecting such plan, as shall be determined by two justices; and such justices may, on the application of the persons having the control or management of any such sewer or drain, or their officer, require the undertakers to make such temporary or other works as they may think necessary for guarding against any interruption of the drainage during the execution of any works which interfere with any such sewer or drain. Provided always, that if the persons having such control or management as aforesaid, and their officer, fail to attend at the time fixed for the opening of any such street, bridge, sewer, drain, or tunnel, after having such notice of the intention of the undertakers as aforesaid, or

* It is incumbent upon the undertakers intending to break up a road to communicate beforehand their proposed plan or method of executing the work to the road authority, and this in a sufficient manner to enable the road authority to judge whether what is proposed ought to be done without modification. The plan should, therefore, show the position on the road of the proposed excavation, and its depth. (Edgware Highway Board *v.* Colne Valley Water Company, 46 L. J. Ch. 889.)

shall not propose any plan for breaking up or opening the same, or shall refuse or neglect to superintend the operation, the undertakers may perform the work specified in such notice without the superintendence of such persons or their officer" (10 & 11 Vic. c. 17, s. 31).

There are several points to which it is necessary to draw attention whilst considering the above clause. I am afraid that the "attendance" of the surveyor "at the time fixed for the opening" or even of one of his assistants, could not always be managed, nor would it be practicable to prepare a "plan" for every opening that might be made by a gas or water company for new services, leaks in mains, &c.; but where it is proposed to carry out any extensive works, such as laying a considerable length of new main, or removing an old one, it is certainly necessary that there should be some "plan" of the manner in which such work is proposed to be carried out by the company.

On referring to the clause it is evident that the first "plan" mentioned must be prepared by, and on behalf of, the company proposing to carry out the work, and this plan must show the exact position on each street of the proposed excavations, and their depth, &c., which "shall be approved of by such persons (having the control of the streets) or their officer," their officer really being the surveyor.

Lower down in the clause another "plan" is referred to in the following words: "or shall not propose any plan for breaking up or opening the same." This plan, or more correctly speaking, a specification of the manner in which the company shall proceed with the work, must be prepared by the surveyor, and if it meets with the approval of his corporation, it can be enforced.

In order to assist town surveyors who may be required to act under this clause, I now give a verbatim copy of a "plan" or specification, under which I compelled a gas company to

concrete, but all other pavements suffer considerably in the process, as it is almost impossible to maintain their strict contour, and with macadamised roadways the result is simply disastrous.

Opening a macadamised roadway does it more harm than the heaviest and most persistent traffic, and it is surprising for what a length of time the surface will show the treatment it has received.

It is unfortunately the practice generally for the men in the employ of a gas or water company, after laying a pipe, to try and ram into the trench all the material they have removed, without allowing for the cubical contents taken up by the pipe, or if they do condescend to cart anything away it is generally the metal, which they think will come in nicely for the repairs of the trench during their liability for such repairs. What ought to be done is, that no filling of ordinary earth, &c., should be allowed to come within at least six inches of the top of the trench, which should then be filled in with good road metal, and as this wears down it should be brought up to the proper level with more metal. In the former plan a hump is seen over the trench, and this hump is a mass of mixed dirt and road-metal, for which there is no cure but its entire removal to a depth of at least six inches and the substitution of good clean road-metal, which would have been the best and most economical plan in the first place.

The clauses following those I have quoted are "penalty clauses" for non-compliance with the provisions of the Act, and need not be here given, but there is one more clause of the Water Works Clauses Act, 1847, dealing with the powers of private individuals to break up streets for the purpose of laying service pipes, which it is necessary to give *in extenso*.

On the question of similar powers to private individuals to break up streets for drains, &c., I shall speak later on in this chapter.

"Any such owner or occupier may open or break up so

much of the pavement of any street as shall be between the pipe of the undertakers and his house, building, or premises, and any sewer or drain therein, for any such purpose as aforesaid, doing as little damage as may be and making compensation for any damage done in the execution of any such work; provided always, that every such owner or occupier desiring to break up the pavement of any street or any sewer or drain therein, shall be subject to the same necessity of giving previous notice, and shall be subject to the same control, restrictions, and obligations in and during the time of breaking up the same, and also reinstating the same, and to the same penalties for any delay in regard thereto, as the undertakers are subject to by virtue of this or the special Act" (10 & 11 Vic. c. 17, s. 52).

It would also seem that the *consent* of the urban authority must be obtained (as well as notice given to them) before a street is broken up (38 & 39 Vic. c. 55, s. 149).

Very often, however, the companies prefer to execute all this work themselves, as they do not like anyone else to interfere with their mains or put in services which may be unfitted for the purpose; consequently they give the necessary notices, execute the work themselves, and charge the owner or occupier with the expense.

The powers under which streets are broken up for telegraphic or telephonic purposes are, as I have previously stated, contained in The Telegraphs Act, 1863, the following being the clauses which refer to this subject:

"The company shall not place a telegraph under any street within the limits of the district over which the authority of the Metropolitan Board of Works extends, or of any city or municipal borough or town corporate, or of any town having a population of thirty thousand inhabitants or upwards (according to the latest census), except with the consent of the bodies having the control of the streets within such respective limits" (26 & 27 Vic. c. 112, s. 9).

"Where the company has obtained consent to the placing, or by virtue of the powers of the company under this Act intends to proceed with the placing of a telegraph under a street or public road, the depth, course, and position at and in which the same is to be placed shall be settled between the company and the following bodies:

"The body having the control of the street or public road.

"The body having the control of the sewerage or drainage thereunder.

"But if such settlement is not come to with any such body the following provisions shall take effect:

"(1.) The company may give to such body a notice, specifying the depth, course, and position which the company desires.

"(2.) If the body to whom such notice is given does not, within 28 days after the giving of such notice, give to the company a counter-notice objecting to the proposal of the company, and specifying the depth, course, and position which such body desires, they shall be deemed to have agreed to the proposal of the company.

"(3.) In the event of ultimate difference between the company and such body, the depth, course, and position shall be determined in England or Ireland by two Justices, and in Scotland by two Justices or the Sheriff" (26 & 27 Vic. c. 112, s. 10).

"Subject to any special stipulations made with a company by the body having the control of a street or public road, and to any determinations, orders, or directions of the Justices, or Sheriff, as aforesaid, where the company proceeds to open or break up a street or public road, the following provisions shall take effect:

"(1.) The company shall give to the bodies between whom respectively and the company the depth, course, and position of a telegraph under such street or public road are hereinbefore required to be settled or determined, notice of their

intention to open or break up such street or public road, specifying the time at which they will begin to do so, such notice to be given, in the case of an underground work, ten days at least, and in the case of an aboveground work, five days at least before the commencement of the work, except in case of emergency, in which case notice of the work proposed shall be given as soon as may be after the commencement thereof.

"(2.) The company shall not (save in case of emergency) open or break up any street or public road except under the superintendence of the bodies to whom respectively notice is by the present section required to be given, unless such bodies respectively refuse or neglect to give such superintendence at the time specified in the notice for the commencement of the work or discontinue the same during the work.

"(3.) The company shall pay all reasonable expenses to which such bodies respectively may be put on account of such superintendence" (26 & 27 Vic. c. 112, s. 17).

It will be seen by the above section that the time required before the work is commenced after service of the notice is considerably longer than that for gas or water mains or for electric lighting wires, and sub-section 3 authorises a payment for the services of the surveyor or other officer attending to superintend the work, which is not the case in the other Acts.

The next clauses are as follows:

"Subject to any such special stipulations as aforesaid, after the company has opened or broken up a street or public road they shall be under the following further obligations:

"(1.) They shall with all convenient speed complete the work on account of which they opened or broke up the same, and fill in the ground and make good the surface, and generally restore the street or public road to as good a condition as that in which it was before being opened or broken up, and carry away all rubbish occasioned thereby:

"(2.) They shall in the meantime cause the place where the

street or public road is opened or broken up to be fenced and watched, and to be properly lighted at night:

"(3.) They shall pay all reasonable expenses of keeping the street or public road in good repair for six months after the same is restored, so far as such expenses may be increased by such opening or breaking up" . . . (26 & 27 Vic. c. 112, s. 18).

"Whenever the permanent surface or soil of any street or public road is broken up or opened by the company it shall be lawful for the body having the control of the street or road, in case they think it expedient so to do, to fill in the ground, and to make good the pavement or surface or soil so broken up or opened, and to carry away the rubbish occasioned thereby, instead of permitting such work to be done by the company; and the cost and expenses of filling in such ground, and making good the pavement or soil so broken up or opened, shall be repaid on demand to the body having the control of the street or road by the company, and in default thereof may be recovered by the body having the control of the street or road from the company, as a penalty is or may be recoverable from the company" (26 & 27 Vic. c. 112, s. 19).

"The company shall not stop or impede traffic in any street or public road, or into or out of any street or public road, further than is necessary for the proper execution of their works. They shall not close against traffic more than one-third in width of any street or public road or of any way opening into any street or public road at one time; and in case two-thirds of such street or road are not wide enough to allow two carriages to pass each other, they shall not occupy with their works at one time more than fifty yards in length of the one-third thereof except with the special consent of the body having the control thereof" (26 & 27 Vic. c. 112, s. 20).

It will be seen that these are much more elaborate clauses

restricting the rights of the telegraph companies than those of the gas and water companies, &c., and as The Telegraphs Act containing these strict clauses was passed in the year 1863, and the Water Works Clauses Act in 1847, it is fair to assume that the clauses of The Telegraphs Act, 1863, were framed to meet certain objections to these clauses and upon experience of their working, and are consequently better and more adapted for the case in point.

To obviate all the difficulties and complications arising out of this constant breaking up of streets, with the attendant inconvenience to the public and damage to the surfaces of the roadways, it was suggested many years ago that subways should be constructed under the surface of the principal streets, in which should be placed all the gas and water mains then existing. And there is no doubt that such a scheme, if properly carried out, would have obviated the difficulties which I have enumerated.

In the construction of these subways, however, provision would have to have been made for the future, and it is doubtful if, twenty years ago, engineers would have foreseen the growth of the requirements of large cities. Gas mains are now four times as large as they were then, and electric cables and hydraulic pressure mains were unknown. It is, however, "never too late to mend," and the sooner subways are provided in the principal streets the better, as irrespective of the damage caused to their surfaces by breaking them up, many of the streets of our large cities are absolutely full of pipes or mains of some description or other, and there is no space for any more, except at most inconvenient depths.

I will now pass on to consider the powers of individuals to break the surface of public streets for the purpose of putting new drains to their premises, or of repairing existing drains.

With regard to the former question, I have given full particulars with regard to new drains or connections with

sewers in the chapter upon "House Drainage," but with regard to the latter question, it will be necessary to make a few remarks.

There is no doubt that the public streets vest in the urban authority, and it is contended that the following clause of the Public Health Act, 1875, prevents any person from breaking up any street without their permission, although it is sometimes questioned whether the words "wilfully displaces" do not mean the doing of an illegal act, such as taking up a stone in a street to annoy or injure a neighbour, or from sheer mischief, rather than that of a legal act for a proper purpose. The clause in question is as follows:

"All streets being, or which at any time become, highways repairable by the inhabitants at large within any urban district and the pavement stones and other materials thereof, and all building implements and other things provided for the purposes thereof, shall vest in and be under the control of the urban authority. . . . Any person who, without the consent of the urban authority, wilfully displaces or takes up, or who injures the pavement, stones, materials, fences, or posts of, or the trees in, any such street, shall be liable to a penalty not exceeding five pounds, and to a further penalty not exceeding five shillings for every square foot of pavement, stones, or other materials so displaced, taken up, or injured; he shall also be liable, in the case of any injury to trees, to pay to the local authority such amount of compensation as the court may award" (38 & 39 Vic. c. 55, s. 149).

Even, however, granting that application must be made before any individual can break up a street, the urban authority would not be likely to withhold their consent if it was for a legitimate purpose; and having disturbed the street, a person must light and guard the opening, and the "hole," as it is called in the clauses following, must be "filled up or otherwise made secure"; but it is very doubtful if he can be called upon to keep the surface of the road in repair for any

length of time, as can be done in the case of water and gas companies, &c. The following are the clauses in question :

"When any building materials, rubbish, or other things are laid or any hole made in any of the streets, whether the same be done by order of the commissioners or not, the person causing such materials or other things to be so laid, or such hole to be made, shall at his own expense cause a sufficient light to be fixed in a proper place upon or near the same, and continue such light every night from sun-setting to sun-rising while such materials or hole remain. And such person shall at his own expense cause such materials or other things and such hole to be sufficiently fenced and enclosed until such materials or other things are removed, or the hole filled up or otherwise made secure." . . . (10 & 11 Vic. c. 34, s. 81).

"In no case shall any such building materials or other things or such hole be allowed to remain for any unnecessary time." . . . (10 & 11 Vic. c. 34, s. 82).

"If any building, or hole, or any other place near any street be, for want of sufficient repair, protection, or inclosure, dangerous to the passengers along such street, the commissioners shall cause the same to be repaired, protected, or inclosed, so as to prevent danger therefrom, and the expenses of such repair, protection, or inclosure shall be repaid to the commissioners by the owner of the premises so repaired, protected, or inclosed, and shall be recoverable from him as damages" (10 & 11 Vic. c. 34, s. 83).

These three sections are incorporated in the Public Health Act, 1875, by 38 & 39 Vic. c. 55, s. 160, and the last clause undoubtedly gives power to the urban authority to repair a "hole" which for want of "sufficient repair" is "dangerous to passengers," but not otherwise, in however unsightly a manner the trench may have been repaired.

The result of this uncertainty has been that a great many towns have inserted in their private improvement Acts, clauses making it compulsory upon all persons to give them from three

to seven days' notice of their intention to break up the streets, specifying the manner in which the work shall be done, and also compelling them to deposit a sum of money in order to secure that the repairs of the street are properly executed.* A better method than this is to insert in any private improvement Act a clause giving powers to the urban authority to execute all drain-work themselves and charge it upon the owners of the property, thus ensuring that any interference with the surface of the street shall be done in a proper manner by men accustomed to the work, and also that the drain itself shall be of perfect workmanship.

Where the town surveyor has no private improvement Act dealing with this question, it is well to frame some regulations as to the manner in which the notice of intention to break up the surface of the street shall be given to him by the person intending to do the work, and if possible to obtain a deposit of money as a guarantee that the surface of the street shall be kept in something like decent repair. Although this may not be strictly legal, it is a very universal practice amongst town surveyors.

The following forms of notices are given as specimens of the description of notice now in use, and are copied verbatim from those which are now enforced in a very large borough in this country:

Borough of

TO THE BOROUGH SURVEYOR,

I hereby apply for permission to break up the footway or roadway, and make excavations in for the purpose of , and I hereby undertake to light, watch, and fence the place during the progress of the works, to temporarily

* In some towns it is the practice to give the builder a junction pipe or block for nothing, thus ensuring his calling to give notice, but this is only successful in the case of new attachments to sewers, in which case the law is much more strict.

make good the surface of the footway or roadway, to remove all rubbish, and to execute and complete the work to the satisfaction of the borough surveyor. I also deposit the sum of for the repair of the surface, and agree to pay the balance if it should cost more than that sum.

(Signature)

(Address)

Witness and receiver .

Received by accountant 189

Surface repaired 189 .

At a cost of

Borough of

189 .

To Mr.

This is to certify that you have paid a deposit of , and that you are hereby permitted to take up the footway or roadway and make excavations in for the purpose of on the undertaking you have given to light, watch, and fence the place during the progress of the works, to temporarily make good the surface of the footway or roadway, to remove all rubbish, and to execute and complete the work to the satisfaction of the borough surveyor; also that you will pay the balance if the surface repairs should cost more than the aforesaid sum of .

Borough Surveyor.

Note.—If the surface repairs should cost less than the deposited sum, the balance will be returned to you by the accountant, who will notify you of the fact.

Notice must be given to the Building Inspector when the work is ready for inspection, and no drainage work must be covered up until it has been examined by the Inspector.

It may be well to add to this authority to break up the streets, the following words—

"This authority may be revoked at any time if found necessary, and it does not in any way relieve the person to whom it is granted from any liabilities he may incur in respect of accidents from anything done in pursuance thereof."

In some towns the following custom prevails in regard to this question.

The person desirous of opening the street for the execution of any work has to apply to the surveyor for a licence, and at the same time deposit a sum sufficient to cover the expense of the work, such sum being estimated and fixed by the surveyor. The corporation then supply one labourer whilst the job is in hand, who, whilst working, takes care that the soil is properly rammed and the surface made good; a mason is also supplied to make any drainage or sewer connections. The deposit is kept for about three months, and the cost of the labourer and mason, and of any subsequent making good the surface of the street, is then deducted, and the balance returned to the person who made the deposit.

This arrangement seems an excellent plan, and is said to work remarkably well where it is in vogue, but whether it is strictly legal is open to considerable question.

CHAPTER XVI.

OBSTRUCTIONS IN STREETS.

FOR convenience, I propose to treat in this chapter some subjects which, strictly speaking, do not come under the head of "obstructions," but they are all questions which have to be considered by the town surveyor; temporary obstructions and other offences with which it is the province of the police to deal are omitted.

The following subjects will therefore be discussed:

(1.) Improving the line of frontages of streets.

(2.) Removing projections.

(3.) Doors and gates opening outwards.

(4.) Vault or cellar coverings.

(5.) Rain-water shutes and down-pipes.

(6.) Blinds or awnings over footpaths.

(7.) Trees overhanging roadways.

(8.) Surface water from private premises running over footpaths.

(9.) Hoardings and scaffolds.

(10.) Dangerous buildings.

(11.) Dangerous quarries.

(1.) *Improving the Line of Frontages of Streets.*—By the Towns Improvement Clauses Act 1847, certain powers were granted which enabled the commissioners to agree with owners of property to set back for the purpose of widening any street,* but this was often found to be difficult and wearisome of accomplishment, consequently in the Public Health Act 1875,

* *Vide* 10 & 11 Vic. c. 34, s. 67.

the following important clause bearing upon this point was inserted.

"Where any house or building situated in any street in an urban district, or the front thereof, has been taken down in order to be rebuilt or altered, the urban authority may prescribe the line in which any house or building, or the front thereof, to be built or rebuilt in the same situation, shall be erected, and such house or building or the front thereof shall be erected in accordance therewith. The urban authority shall pay or tender compensation to the owner or other person immediately interested in such house or building for any loss or damage he may sustain in consequence of his house or building being set back or forward, the amount of such compensation in case of dispute to be settled by arbitration in manner provided by this Act" (38 & 39 Vic. c. 55, s. 155).

This clause gives an excellent power to the sanitary authority, especially in older towns, to lay down improved building lines upon the plan of their town, and thus set back the line of buildings as opportunity offers.

In assessing the value of compensation to be paid to the owner for setting back his property, the following points should be considered:

(1.) The value of the area of the land given up to the public.

(2.) The loss of available and useful space to the premises.

(3.) If any use is made by the owner of the land given up to the public by constructing cellars underneath, the amount of compensation should be less.

(4.) The amount the owner will have to expend to make good the sides of the neighbouring premises thus exposed by his setting back must be considered.

A surveyor should be very careful to recollect if any building line has been laid down in any street when the plans of new buildings are deposited with him for approval. If these plans are approved without any notice being given to

the owner to set back, it is questionable whether he can afterwards be called upon to do so.*

(2.) *Removing Projections of Buildings.*—The Towns Improvement Clauses Act 1847, made provision for setting back any house or building, or any part which projected beyond the regular line of street when taken down, on payment of compensation,† and this and the following sections were incorporated in the general Public Health Act 1875.‡

"The commissioners may give notice to the occupier § of any house or building to remove or alter any porch, shed, projecting window, step, cellar, cellar-door, or window, sign, sign-post, sign-iron, show-board, window shutter, wall, gate, or fence, or any other obstruction or projection erected or placed after the passing of the special Act, against or in front of any house or building within the limits of the special Act, and which is an obstruction to the safe and convenient passage along any street, and such occupier shall within fourteen days after the service of such notice upon him, remove such obstruction or alter the same in such manner as shall have been directed by the commissioners, and in default thereof shall be liable to a penalty not exceeding forty shillings; and the commissioners in such case may remove such obstruction or projection, and the expense of such removal shall be paid by the occupier so making default, and shall be recoverable as damages; provided always, that except in the case in which such obstructions or projections were made or put up by the occupier, such occupier shall be entitled to deduct the expense of removing the same from the rent payable by him to the owner of the house or building" (10 & 11 Vic. c. 34, s. 69).

The wall of a garden in front of a house, and shrubs in

* *Vide* Fitzgerald's 'Public Health and Local Government Act 1875,' 3rd edition, p. 166.

† *Vide* 10 & 11 Vic. c. 34, s. 68.

‡ *Ibid.* ss. 69 and 70.

§ Or *Owners*, see s. 160, 38 & 39 Vic. c. 55.

the garden, which encroach on the street, come within the words "any other obstruction" in this section.*

It is doubtful, however, if trade signs projecting at such a height as not to be "an obstruction to the safe and convenient passage along any street" can be removed under this section, however unsightly they may be; nor does it appear that flag poles or flags can be ordered to be removed when at such a height as to cause no obstruction.

The following clause, however, of the Public Health Act 1875, affects the question of new projections much more closely.

"It shall not be lawful in any urban district, without the written consent of the urban authority, to bring forward any house or building forming part of any street or any part thereof, beyond the front wall of the house or building on either side thereof, nor to build any addition thereto beyond the front of the house or building on either side of the same. Any person offending against this enactment shall be liable to a penalty not exceeding 40*s.* for every day during which the offence is continued after written notice in this behalf from the urban authority" (38 & 39 Vic. c. 55, s. 156).

Difficulties having, however, arisen in connection with this clause, it was amended in 1888 by the Public Health (Building in Streets) Act 1888, which repeals the above section and provides in place thereof as follows. "It shall not be lawful in any urban district without the written consent of the Urban Authority to erect or bring forward any house or building in any street or any part of such house or building beyond the front main wall of the house or building on either side thereof in the same street, or to build any addition to any house or building beyond the front main wall of the house or building on either side of the same" (51 & 52 Vic. c. 52, s. 3).

* *Vide* Fitzgerald's 'Public Health and Local Government Act 1875,' 3rd edition, p. 174.

With regard to obstructions erected before the passing of the special Act, the commissioners may cause the same to be removed or altered as they think fit—

"Provided that they give notice of such intended removal or alteration to the occupier* of the house or building against or in front of which such alteration or removal is begun; and if such obstructions or projections shall have been lawfully made, they shall make reasonable compensation to every person who suffers damage by such removal or alteration."†

Here the words "*reasonable* compensation" are difficult of construction and lead frequently to long litigation.

(3.) *Doors or Gates opening outwards.*—

Section 71 of the Towns Improvement Clauses Act, 1847, enacts that "All doors, gates and bars put up after the passing of the special Act within the limits thereof, and which open upon any street, shall be hung or placed so as not to open outwards, except when in the case of public buildings the commissioners allow such doors, gates or bars to be otherwise hung or placed; and if (except as aforesaid) any such door, gate or bar be hung or placed so as to open outwards on any street, the occupier of such house, building, yard or land shall, within eight days after notice from the commissioners to that effect, cause the same to be altered so as not to open outwards; and in case he neglect so to do the commissioners may make such alteration, and the expenses of such alteration shall be paid to the commissioners by such occupier, and shall be recoverable from him as damages, and he shall in addition be liable to a penalty not exceeding 40*s*."

Section 72 of the same Act further enacts, "If any such door, gate or bar was before the passing of the special Act hung so as to open outwards upon any street, the commissioners may alter the same so that no part thereof when open shall project over any public way."

* Or owner, see 38 & 39 Vic. c. 55, s. 160.

† 'Towns Improvement Clauses Act 1847,' s. 70.

It is naturally necessary that doors or gates of all public buildings should hang so as to open outwards, so as to give a free and easy exit in case of panic, many serious accidents having arisen from a want of this precaution; but with regard to private premises the case is altogether different, and if doors and gates were allowed to open outwards, they would soon become a dangerous and intolerable nuisance.

It will be seen that there are two courses to be pursued in connection with this offence.

The first is where the door, gate or bar has been placed before the passing of the Towns Improvement Clauses Act in 1847, in which case the "commissioners may alter the same, so that no part thereof when open shall project over any public way." This duty of course rests with the town surveyor, and in many cases it is not easy of execution, as structural difficulties may have to be encountered and overcome.

In the second case, where the door, gate or bar has been placed since the passing of the Act in 1847, certain penalties are incurred by the occupier or owner, and the commissioners may also alter the door, gate or bar at his expense.

The following specimen form of notice to be served in connection with a case of this description may be of use:

TOWN SURVEYOR'S OFFICE.

Sir,

I beg leave to give you notice that of the premises in your occupation opens outwards, and when open, projects into the street called or known as

I have therefore to require that you will be good enough to have such altered so that it shall not open outwards into the said street, within eight days next after your receipt of this notice.

I beg leave also to give you notice that if you neglect to make the alteration required within the period specified by this notice, you render yourself liable to a penalty of 40*s*., and

I shall proceed to make the necessary alterations, and recover the costs and penalties from you as the law directs.

I am, Sir, you obedient Servant,

_____

Town Surveyor.

To _____

(4.) *Vault or Cellar Coverings.*—

Section 73 of the Towns Improvement Clauses Act 1847 enacts, "When any opening is made in any pavement or footpath within the limits of the special Act, as an entrance into any vault or cellar, a door or covering shall be made by the occupier* of such vault or cellar, of iron, or such other materials, and in such manner as the commissioners direct, and such door or covering shall from time to time be kept in good repair by the occupier of such vault or cellar; and if such occupier do not within a reasonable time make such door or covering, or if he make any such door or covering contrary to the directions of the commissioners, or if he do not keep the same when properly made in good repair, he shall for every such offence be liable to a penalty not exceeding five pounds."

Besides the penalty, the person negligently leaving the covering in a dangerous condition would be liable to an action for damages at the suit of anyone who has sustained an injury in consequence of the covering being so kept.†

There is another clause incorporated in the Public Health Act 1875 from the Towns Police Clauses Act 1847, upon this subject, which is as follows:

"Every person who leaves open any vault or cellar, or the entrance from any street to any cellar or room underground, without a sufficient fence or hand rail, or leaves defective the

* Or owner

† *Vide* Fitzgerald's 'Public Health and Local Government Act, 1875,' 3rd edition, p. 175.

door, window or other covering of any vault or cellar . . . . shall be liable to a penalty not exceeding 40*s.* for each offence, or in the discretion of the justice before whom he is convicted may be committed to prison, there to remain for a period not exceeding 14 days" (10 & 11 Vic. c. 89, s. 28).

In the Public Health Acts Amendment Act 1890* these clauses are somewhat superseded, though they are not repealed, in the following manner:

"All vaults, arches, and cellars under any street, and all openings into such vaults, arches, or cellars in the surface of any street, and all cellar-heads, gratings, lights, and coal holes in the surface of any street, and all landings, flags, or stones of the path or street supporting the same respectively, shall be kept in good condition and repair by the owners or occupiers of the same, or of the houses or buildings to which the same respectively belong.

"Where any default is made in complying with the provisions of this section, the urban authority may, after twenty-four hours' notice in that behalf, cause anything in respect of which such default is made to be repaired or put into good condition, and the expenses of so doing shall be paid to the urban authority by such owner or occupier respectively, or in default may be recovered in a summary manner." (53 & 54 Vict. chap. 59, part III. sec. 35.)

It will be seen by the above clause that not only is the owner or occupier responsible for the repair of the "door or covering" to the vault or cellar, but also for the structure of the vault or cellar itself and the "landings, flags or stones" in connection therewith, which is a great improvement upon the clauses of the parent Act.

In accordance with the provisions contained in the section of the Towns Improvement Clauses Act 1847, which I have

* It must be noted in connection with this Act, that it is not compulsory like the Public Health Act 1875, but is permissive and can only be adopted by the Local Authority after they have complied with certain forms and regulations.

quoted, that the "door or covering shall be made by the occupier of such vault or cellar of iron or such other materials, and in such manner as the commissioners direct," most towns in this country have prescribed the size and materials of which they shall be made, the size being often limited to 6 feet in length, by 20 inches projection, from the line of plinth of the building, for cellar coverings or pavement lights as they are sometimes called, and 12 inches in diameter for coal plates.

Hayward's patent hexagonal and semiprismatic pavement lights, however, have obviated the danger of slipping upon this description of covering, and consequently little or no inconvenience is experienced, even if the greater portion of the foot pavement is covered by them.*

Coal-hole plates should be so firmly fixed as to prevent the possibility of their shifting, even when the rebate of the flag stone into which they are dropped is worn, and also to prevent mischievous persons from raising them.

Here let me state that no person can, without the written consent of the urban authority, cause "any vault, arch or cellar to be newly built or constructed under the carriageway of any street" (38 & 39 Vic. c. 55, s. 26); but from this section it does not appear illegal to construct a vault, arch or cellar under the footpath, which would generally be the extent to which such constructions would be extended. However, it is generally assumed that the more general powers contained in section 149 of the same Act, by which all "streets and the pavement stones and other materials thereof" vest in and are under the control of the urban authority, give the necessary powers to prevent the construction of cellars under any portion of the foot-pavement without the consent of the

* In the City of London these patent lights have been fixed in the pavement round the whole of the frontage of Mansion House Buildings, at the corner of Queen Victoria Street, and also over the whole of the pavements in Draper's Gardens, besides many other equally crowded thoroughfares, without the least inconvenience being experienced.

urban authority, although it is very doubtful if the subsoil of a street vests in the authority in any way whatever, beyond any powers conferred on them by various Acts of Parliament.

The usual practice adopted is for any person who requires to construct a cellar under the foot-pavement or carriageway of any street, to apply to the urban authority for the necessary permission to do so. In granting the permission, the urban authority call upon the owner of the premises to which the proposed vault or cellar is attached, to enter into an agreement acknowledging that the cellar or vault is only an easement, and agreeing to remove the encroachment whenever called upon by the urban authority to do so.

These agreements and any other similar easements should be kept together in a book, which may be called the "Easement Book," and indexed in such a manner that a reference can be easily made at any time to any easement that has been granted.

(5.) *Rain-water from Shutes or Down Pipes.*—

Water may not be allowed to drip on to the pavements of the streets from the adjoining houses, and the following clause from the Towns Improvement Clauses Act 1847, has been incorporated with the Public Health Act 1875:

"The occupier of every house or building in, adjoining, or near to any street shall, within seven days next after service of an order of the commissioners for that purpose, fit up and keep in good condition a shute or trough of the whole length of such house or building, and shall connect the same either with a similar shute on the adjoining house, or with the pipe or trunk to be fixed to the front or side of such building from the roof to the ground, to carry the water from the roof thereof in such a manner that the water from such house or any portico or projection therefrom shall not fall upon the persons passing along the street or flow over the footpath; and in default of compliance with any such order within the period aforesaid, such occupier shall be liable to a penalty not

exceeding 40*s.* for every day that he shall so make default" (10 & 11 Vic. c. 34, s. 74).

In many private Town Improvement Acts, the cost of the repair necessary under an order to do so from the urban authority may be deducted by the occupier from the rent payable to the owner of the premises, thus ensuring the work being done more quickly.

The following is a specimen notice to be served upon the occupier to repair or put new shutings to his house:

I beg to give you notice that the eaves, shuting, or projecting cornice* to the house or building No. in your occupation, is out of repair. A penalty of 40*s.* will be incurred if this shuting be not repaired within seven days from the date of this notice (and under the Special Improvement Act the cost of such repair may be deducted from the rent payable to the owner).†

I am, your obedient Servant,

_____

Town Surveyor.

To _____

It is a common practice in most towns for the urban authority to provide and fix trunks or troughs across their footpaths into which the down pipes from the rain-water shutes can empty their contents.

(6.) *Blinds or Awnings over Footpaths.*—

These may be dealt with as obstructions under sec. 69 of the Towns Improvement Clauses Act 1847, which I have already quoted,‡ but they are more particularly alluded to in the Police Clauses Act 1847, in the following section:

"Every person who . . . places any blind, shade, cover-

* In the Act the words used are "shoot" and "trough."

† These words must be omitted if there is no special Improvement Act.

‡ *Vide* p. 205.

ing, awning, or other projection over or along any such footway, unless such blind, shade, covering, awning or other projection is 8 feet in height, at least in every part thereof from the ground, shall be liable to a penalty not exceeding 40*s.* for each offence, &c." . . . (10 & 11 Vic. c. 89, s. 28).

Thus legalising the fixing of shop-blinds, &c., provided they are at least 8 feet in height, and consequently no obstruction to the traffic.

In order to make the blinds or awnings sufficiently secure where they are of large dimensions, it is very usual for the owner or occupier of the premises to which the blind or awning is to be attached, to seek and obtain the consent of the local authority to fix iron sockets in the kerb of the footpath into which iron or wood standards are inserted for the purpose of supporting the outer part of the blind or awning; and there can be no objection to this practice provided that the work is efficiently performed and to the satisfaction of the town surveyor, although in some towns this is objected to on account of the obstruction to traffic these standards cause where the footwalks are narrow.

(7.) *Trees overhanging Roadways.*—

It used formerly to be considered by road surveyors and others* that great injury was caused to roadways by overhanging branches of trees or bushes, which were supposed to exclude the light and air from the roadway and thus damage it, hence powers were given to local authorities, as surveyors of highways, to compel occupiers of premises adjoining the

* Sir Fred. Parnell in his celebrated work upon roads has the following paragraph upon this subject :—

The great advantage of having a road perfectly exposed to the action of the sun and wind will be more accurately conceived by referring to writers of science on evaporation. Dr. Halley states that one-tenth of an inch of the surface of the sea is raised per diem in vapour. He also says that the winds lick up the water somewhat faster than it exhales by the heat of the sun. Other writers say the dissipation of moisture is much accelerated by the agency of sweeping winds, the effects being sometimes augmented five to ten times.

Trees are particularly injurious by not allowing the sun and wind to have free action on the surface of roads producing evaporation. Besides the benefit which

roadways to cut back and prune their trees or hedges in order to prevent this damage, and these powers were given either in Private Improvement Acts or the General Highways Act 1833 (5 & 6 William, chap. 50, sec. 65) which was incorporated with the Public Health Act 1875 by sec. 144, (38 & 39 Vic. c. 55, sec. 144). The following was the form of notice usually adopted for this purpose:

To _____

You are hereby required to cut, prune, and trim your hedges adjoining the highway leading from to , and also to cut down, prune, or lop the branches of trees, bushes and shrubs growing in or near such hedges and other fences adjoining thereto, in such manner that the said highway shall not be prejudiced by the shade thereof, and that the sun and wind may not be excluded therefrom. And you will further take notice, that if you shall neglect so to do within five days of the delivery hereof, I shall proceed to have the said hedges, trees, and bushes cut and pruned, according to the powers and provisions of the various Acts of Parliament relating thereto.* And further, that I shall also proceed to recover from you the penalties in this respect imposed by the said Acts of Parliament.

Dated this day of

_____

Surveyor.

It is, however, now very seldom that overhanging

a road receives from its drying rapidly by an open exposure to the atmosphere, there is another of great importance, namely, that of affording to horses the advantage of free respiration; for it is well known that the power of a horse to perform work with ease, particularly when moving rapidly, depends upon the quantity of cool and fresh air that he can pass through his lungs. If the cause of horses tiring or becoming ill under their work be carefully examined into, it will often be found that it is not their muscles or limbs that fail them, but their wind; and therefore it is particularly important to have a road so circumstanced that a horse may on all parts of it have the benefit of a free current of air.

* Referring to the Acts I have quoted.

branches of trees or hedges cause any damage to the roadways within an urban district, and unless they are an actual obstruction to the traffic,* or interfere with the light from the public lamps, the growth of trees near urban roads and streets should be encouraged; indeed it is now a common practice to plant trees close alongside the roadway, the branches of which must of necessity hang over it, and cause no damage if the roadway is properly formed and attended to.

(8.) *Surface Water from Private Premises running over Footpaths.*

It frequently happens that the rain-water which falls upon a front garden or courtyard finds its way, for want of a sufficient drain, out of the gate and across or along the public footpath, thus causing annoyance to pedestrians, even if it does no injury to the path. There does not seem to be any clause in the Public Health Act, 1875, to meet this objection, for the section which I have given with reference to rain-water shutes and down pipes (10 & 11 Vic. c. 34, s. 74), does not apply to such cases, as it only refers to water from the "roof or any portico or projection," and not to water falling upon the surface of a garden or courtyard, nor is there anything in the Highways Acts which can be brought to bear upon the subject.

If, however, any injury is caused to the footpath, no doubt the cause of offence may be stopped, or the perpetrator prosecuted or indicted in default.

(9.) *Hoardings and Scaffolds.*

When buildings are in course of erection, or repairs are being carried out to them, it is generally necessary that the person engaged in the work should construct either a hoarding or inclosure, or at all events a scaffold, so as to

* In the case of an obstruction caused by trees or shrubs they can be dealt with under section 156 of the Public Health Act 1875, *vide ante* page 206 of this book.

execute the work properly. Upon this point the following clause of the Towns Improvement Clauses Act has been incorporated with the Public Health Act, 1875:—

"Every person intending to build, or take down any building within the limits of the special Act, or to cause the same to be so done, or to alter or repair the outward part of any such building, or to cause the same to be so done, where any street or footway will be obstructed or rendered inconvenient by means of such work, shall, before beginning the same, cause sufficient hoards or fences to be put up in order to separate the building where such works are being carried on from the street, with a convenient platform and handrail if there be room enough, to serve as a footway for passengers, outside of such hoard or fence, and shall continue such hoard or fence with such platform and handrail as aforesaid, standing and in good condition, to the satisfaction of the commissioners, during such times as the public safety or convenience requires, and shall, in all cases in which it is necessary in order to prevent accidents, cause the same to be sufficiently lighted during the night.* And every such person who fails to put up such fence or hoard or platform with such handrail as aforesaid, or to continue the same respectively standing, and in good condition as aforesaid, or who does not, while the said hoard or fence is standing, keep the same sufficiently lighted in the night, or who does not remove the same when directed by the commissioners within a reasonable time afterwards, shall for every such offence be liable to a penalty not exceeding 5*l.*, and a further penalty not exceeding 40*s.* for every day while such default is continued" (10 & 11 Vict. c. 34, s. 80).

Sec. 34 of the Public Health Acts Amendment Act,

* No person can put up hoards or scaffolds in the streets without first obtaining the consent of the urban authority, *vide* sections 144 and 149 of the Public Health Act 1875. Many towns also have private improvement Acts with very binding clauses on this subject, empowering the surveyor to demand a fee for a licence to erect a hoarding, and empowering him to remove these after notice, &c.

1890, to which allusion has already been made, repeals the above Section where the Amendment Act has been adopted, and is as follows:—

"(1.) Every person intending to build or take down any building, or to alter or repair the outward part of any building, street or court, shall:—

(*a.*) before beginning the same, unless the urban authority otherwise consent in writing, cause close-boarded hoards or fences to the satisfaction of the urban authority to be put up in order to separate the building from the street or court;

(*b.*) if the urban authority so require, make a convenient covered platform and handrail to serve as a footway for passengers outside of such hoard or fence;

(*c.*) continue such hoard or fence with such platform and handrail as aforesaid standing and in good condition to the satisfaction of the urban authority during such time as they may require;

(*d.*) if required by the urban authority, cause the same to be sufficiently lighted during the night;

(*e.*) remove the same when required by the urban authority.

"(2.) Every person who fails to comply with any of the provisions of this section shall be liable to a penalty not exceeding five pounds, and to a daily penalty not exceeding forty shillings.

"(3.) Where this part of this Act is adopted, the eightieth section of the Towns Improvement Clauses Act, 1847, shall be repealed, and this section shall be deemed to be substituted therefor."—(53 & 54 Vict., ch. 59, sec. 34.)

Hoardings and scaffoldings are now so scientifically erected as to be little or no inconvenience to foot-passengers. Care must, however, be taken to see that in the erection of a hoarding the doors or gates in it shall not open outwards, and the police should be instructed to prevent carts being backed in and left standing across the footpath.

The surveyor must exercise great discretion in the length of time he allows a hoarding to remain; without undue hardship on the builder, he must study at the same time the more important question of the public convenience.

Under the Advertising Stations (Rating) Act, 1889, hoardings erected for the exhibition of advertisements "but "not otherwise occupied" are liable to be rated "in respect "thereof to the relief of the poor and to all local rates "according to the value of such use as aforesaid" (52 & 53 Vict. ch. 27, sec. 3), and the local authority may also grant licences on payment of certain fees for the erection of hoardings "upon or over any part of any public highways, "etc." (*Ibid.* sec. 5.) These powers give a much greater control over such obstructions, and are now very generally enforced.

(10.) *Dangerous Buildings.*

This is the last, though by no means the least, of the series of "obstructions" I have enumerated. Here, again, very grave responsibility rests with the surveyor to determine what is a dangerous building, and in what manner it shall be rendered safe and secure, for his opinion is apparently legally conclusive on this matter.

The following is the clause of the Towns Improvement Clauses Act which deals with ruinous or dangerous buildings:—

"If any building or wall, or anything affixed thereon, within the limits of the special Act, be deemed by the surveyor of the commissioners to be in a ruinous state, and dangerous to passengers or to the occupiers of the neighbouring buildings, such surveyor shall immediately cause a proper hoard or fence to be put up for the protection of passengers,* and shall cause notice in writing to be given to the owner of such building or wall, if he be known and

* This is scarcely ever feasible, or of the slightest use if done, but is evidently a necessity under the Act.

resident within the said limits, and shall also cause such notice to be put on the door or other conspicuous part of the said premises, or otherwise to be given to the occupier thereof, if any, requiring such owner or occupier forthwith to take down, secure or repair such building, wall or other thing, as the case shall require. And if such owner or occupier do not begin to repair, take down or secure such building, wall or other thing, within the space of three days after any such notice has been so given or put up as aforesaid, and complete such repairs or taking down or securing as speedily as the nature of the case will admit, the said surveyor may make complaint thereof before two justices to order the owner, or in his default the occupier (if any) of such building, wall, or other thing, to take down, rebuild, repair or otherwise secure, to the satisfaction of such surveyor, the same, or such part thereof as appears to them to be in a dangerous state, within a time to be fixed by such justices. And in case the same be not taken down repaired, rebuilt or otherwise secured within the time so limited, or if no owner or occupier can be found on whom to serve such order, the commissioners shall with all convenient speed cause all or so much of such building, wall, or other thing as shall be in a ruinous condition, and dangerous as aforesaid, to be taken down, repaired, rebuilt, or otherwise secured in such manner as shall be requisite, and all the expenses of putting up every such fence, and of taking down repairing, rebuilding, or securing such building, wall or other thing shall be paid by the owner thereof" (10 & 11 Vic. c. 34, s. 75).

Great care must be observed in seeing that the notices are properly prepared and served in accordance with sections 266 and 267 of the Public Health Act, 1875, and the town clerk, as the legal adviser of the sanitary authority, should be consulted (in this, as in all cases requiring notices) by the surveyor.

For a long time it was held that the opinion of the surveyor as to whether the building was dangerous was sufficient if he could prove his case to the Magistrate, but the Court of Queen's Bench has held that evidence can be tendered on the other side to disprove the evidence of the surveyor. In this case, as in many others, the surveyor can only give his evidence to the best of his ability and knowledge, and trust to obtaining a verdict in his favour.

It sometimes happens that a tall chimney shaft, wall, or other erection may apparently be perfectly safe, whereas in a high gale of wind it may be blown down.

Many tall chimney shafts rock in an alarming manner in a high wind,* but he would be a bold surveyor who would order some of these expensive structures to be pulled down in the face of the opposition he would receive.†

A curious case of some difficulty in connection with dangerous buildings has come under my notice, where a house was built with the approval of the urban authority, and after completion and occupation, the attention of the surveyor was called to the fact that a large piece of rock at the back of the house, from which the site had been excavated for the purpose of its erection, was in a dangerous condition, and likely to fall at any moment and cause great damage to property, or even loss of life. The clerk to the urban authority, when consulted, was of opinion that the surveyor could do nothing in the matter, as the case was not met in any way by the Act. Nor does it appear that an isolated

* In the year 1844, Mr. E. A. Cowper stated, at a meeting of the Institution of Civil Engineers, that "he had been on the top of a chimney which rocked an inch in a moderate wind; some chimneys would vibrate as much as four inches at the top; and he had known a large square chimney to move one-eighth of an inch at sixteen feet from the ground. (*Vide* 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. xxvii. page 100.)

† Whilst the first edition of this work was in the press and the above words were being written, the terrible disaster arising from the falling of an immense chimney shaft at Bradford took place, the result of which was the death of upwards of forty persons and great destruction of property.

building which might be dangerous to the occupants can be dealt with in any way.

The following is given as a specimen notice to serve with reference to a dangerous structure :—

NOTICE.

To (A) *the Owner of the ruinous and dangerous* (B) *under-mentioned and the occupier thereof.*

Whereas a certain (B) situated at within the borough of , in the county of , is deemed by me, the undersigned, the surveyor of the mayor, aldermen and burgesses of the said borough of , acting by the council as the urban sanitary authority for the same, to be in a ruinous state, and dangerous to passengers or to the occupiers of neighbouring buildings :—

Therefore take notice, that you are hereby required, in pursuance of the provisions in that behalf of the Public Health Act 1875, and the Towns Improvement Clauses Act 1847, to take down, repair or secure the said (B).

And that if you do not or if neither of you does begin to take down, repair, or secure the said (B) within the space of three days after this notice has been served upon you or put upon the said premises, and complete such taking down repairing or securing as speedily as the nature of the case will admit, I shall cause complaint thereof to be made before two justices in accordance with the provisions of the statutes aforesaid.

Dated this day of 18

Surveyor of the said Urban Sanitary Authority.

A. The name and description of the owner or occupier, or the names, &c., of both should be here inserted.

B. Building, wall, or anything affixed thereon.

Before closing this chapter upon "Obstructions in Streets," I give the following clause from the "Towns Improvement Clauses Act," which comes after two other sections of the

same act principally dealing with building materials, rubbish, or holes in streets; and although in this clause the word "building" is used, the section cannot be taken as referring to dangerous buildings, although it may undoubtedly be used where it is required on account of waste land, &c., being left in an unprotected and dangerous state:—

"If any building or hole or any other place near any street be, for want of sufficient repair, protection or inclosure, dangerous to the passengers along such street, the commissioners shall cause the same to be repaired, protected or inclosed so as to prevent danger therefrom; and the expense of such repair, protection or inclosure shall be repaid to the commissioners by the owner of the premises so repaired, protected or inclosed, and shall be recoverable from him as damages" (10 & 11 Vict. c. 34, s. 83).

Since writing the first edition of this book, the Quarry Fencing Act, 1887, has been passed, which provides as follows:—

"Where any quarry dangerous to the public is in open or uninclosed land, within fifty yards of a highway or place of public resort dedicated to the public, and is not separated thereform by a secure and sufficient fence, it shall be kept reasonably fenced for the prevention of accidents, and unless so kept shall be deemed to be a nuisance liable to be dealt with summarily in manner provided by the Public Health Act, 1875" (50 & 51 Vict. c. 19, s. 3). And the Act further states that:—

"The term 'quarry' includes every pit or opening made for the purpose of getting stone, slates, lime, chalk, clay gravel, or sand, but not any natural opening." *

I have purposely omitted any reference to temporary obstructions in streets, which are naturally subjects for the interference of the police, but I think I have enumerated all those which require the attention of the town surveyor.

* *Ibid.* Sect. 4.

CHAPTER XVII.

IMPROVEMENT OF PRIVATE STREETS.

PRIOR to the passing of the Public Health Act 1875 the improvement of private roads and streets was dealt with under section 69 of the Public Health Act 1848, but the clause under which the town surveyor now works is that which is so well known as the 150th section of the Public Health Act 1875, and is as follows:

"Where any street within any urban district (not being a highway repairable by the inhabitants at large), or the carriageway, footway, or any other part of such street is not sewered, levelled, paved, metalled, flagged, channeled and made good, or is not lighted to the satisfaction of the urban authority, such authority may, by notice addressed to the respective owners or occupiers of the premises fronting, adjoining or abutting on such parts thereof as may require to be sewered, levelled, paved, metalled, flagged or channeled, or to be lighted, require them to sewer, level pave, metal, flag, channel or make good, or to provide proper means for lighting the same within a time to be specified in such notice.

Before giving such notice the urban authority shall cause plans and sections of any structural works intended to be executed under this section, and an estimate of the probable cost thereof, to be made under the direction of their surveyor; such plans and sections to be on a scale of not less than one inch for eighty-eight feet for a horizontal plan, and on a scale of not less than one inch for ten feet for a vertical section, and, in the case of a sewer, showing the depth of such sewer below the surface of the ground: such plans, sections and

estimate shall be deposited in the office of the urban authority, and shall be open at all reasonable hours for the inspection of all persons interested therein during the time specified in such notice; and a reference to such plans and sections in such notice shall be sufficient without requiring any copy of such plans and sections to be annexed to such notice.

If such notice is not complied with, the urban authority may, if they think fit, execute the works mentioned or referred to therein; and may recover in a summary manner the expenses incurred by them in so doing from the owners in default, according to the frontage of their respective premises, and in such proportion as is settled by the surveyor of the urban authority, or (in case of dispute) by arbitration in manner provided by this Act; or the urban authority may by order declare the expenses so incurred to be private improvement expenses.

"The same proceedings may be taken and the same powers may be exercised in respect of any street or road of which a part is or may be a public footpath or repairable by the inhabitants at large, as fully as if the whole of such street or road was a highway not repairable by the inhabitants at large" (38 & 39 Vic. c. 55, s. 150).

One has only to look at the number of footnotes that follow this clause, both in "Glenn" and "Fitzgerald," to see that it requires some considerable interpretation. In the tenth edition of Glenn's "Law of Public Health," no less than twenty-two pages of footnotes follow this clause; but I propose in this chapter to endeavour to call attention to some of its engineering discrepancies, and to point out the duties of the town surveyor in connection with its enforcement.

First then, I conclude that it is the duty of the surveyor to call the attention of the urban authority to the fact that any street within his district (not being a highway repairable by the inhabitants at large) is not "sewered, levelled, paved, &c."; but there is no express order for him to do so, but with

whoever this duty rests, it is no doubt the surveyor's duty to be certain that the street in question has never been dedicated to the public or repaired at the cost of the rates, but is really a private street within the meaning of the Act.

Before proceeding to give the manner of putting the 150th section into force, it is necessary to draw attention to some of its wording.

The word "sewered" no doubt is also meant to include all drains both for house sewage and surface water falling on the street, &c., and may be used in the same comprehensive manner that the word "sewerage" is generally employed.

"Levelled" is also rather a vague term, but it has been held to refer only to the level or cross section of the street itself, there being no power to charge the adjacent owners with the expense of altering the level of the street so as to make it conform to a street with which it connects. The word "formed" would in this case have therefore been a more appropriate phrase.

"Paved, metalled, flagged, channeled and made good" are very precise directions, but why both the words "paved" and "metalled" are used is not clear. Is the paving to be placed on the top of the metalling or vice versâ? It seems ludicrous to have used both words. The word "kerbed" also ought no doubt to have been inserted, as no street either urban or suburban can be formed without this necessary adjunct.

These very precise directions, if carried out in their entirety, would cause great injustice to the adjacent owners of the property who had to bear the expense, for although "paving" and "flagging" may be necessary for streets situated in a town itself, they would be perfectly unnecessary for a suburban road, and it is to this latter class of work that the section is more frequently applied. There are generally very few badly maintained private steets in the heart and busiest parts of a town, much difference of opinion consequently exists in different localities as to what the requirements shall be.

Some urban authorities insist that the roadways shall be paved with granite setts or wood blocks, the footpaths being flagged or paved with asphalte, while others are content with ordinary macadamised roadways and gravelled paths.

There are great doubts, and in fact a decision of the Master of the Rolls has been given upon the point, whether a Local Authority can adopt a street unless the whole of the very remarkable conditions, as set forth in the clause, have been carried out by, and at the cost of, the abutting owners; if however, the Local Authority do not want to legally adopt the street, it appears that they are at liberty to specify what description of work they require.*

There can be no doubt that the town surveyor must use considerable discretion in deciding what class of work should be demanded, and he must be greatly guided by the situation and requirements of the street in question and the description and value of the adjoining property.

With reference to the words "or is not lighted," my opinion is that nearly all private streets are at once lighted by the urban authority out of the rates, so soon as buildings are erected at its sides or it is found necessary for the public convenience to do so. A reference to section 161 of the Public Health Act 1875 will show that there is no exclusion of private streets for that purpose, and for many obvious reasons it is better that the urban authority should themselves undertake this duty rather than throw it upon private individuals.

There would also be considerable difficulty in enforcing this portion of the clause, as although the lamp columns might be erected, it is exceedingly doubtful if the Gas Company would provide the gas unless they were sure of

* Upon this point and on many others in connection with this question, see Mr. Smith's paper on "Private Streets and the 152nd section of the Public Health Act 1875," read at the Annual Meeting of the Association of Municipal and Sanitary Engineers in London in 1882. (*Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. viii. page 123.)

being paid for it quarterly by some one, and the Act does not prescribe who this "some one" is to be.

Having thus far drawn attention to some of the wording of the clause, it is now necessary to discuss the duties of the town surveyor in connection with it.

It will be seen that notice has to be addressed to the owners or occupiers of "premises fronting, adjoining or abutting, *on such parts thereof* as may require to be sewered, levelled, paved, &c." It is often found that although the greater portion of a certain private street may be in a shocking state of repair, perhaps just a small length here and there opposite portions of different frontages may not be so bad: for instance, the path may be well gravelled and kerbed and a narrow channel gutter inserted against a wretchedly constructed roadway. It is often open to question if the owners of these properties against which these partial improvements have been effected can expect to escape their liability. If they can, it complicates still more the working of an already greatly complicated clause.

"Before giving such notice the urban authority shall cause plans and sections . . . to be made under the direction of their surveyor."

This order involves some considerable amount of work. Very accurate surveys must be made and plotted to a large scale, levels must be taken, and where sewers have to be included in the notice it is often necessary to extend the survey considerably, in order to make provision for future extensions of streets or buildings or for the existing sewerage system. The clause is very particular in stating that the "depth of such sewer below the surface of the ground" must be shown, but no mention is made about the size. The latter point being of quite as great importance it would be thought as the depth, the question also at once arises, whether the new sewer must be specified of such a size as only to meet the requirements of the street alone, or may it be made of such an

area as will carry the sewage of a considerable district? It would be most unjust to expect the owners of property to pay for a sewer larger than was required for the street in respect of which they were responsible, and if legal, the better plan would be for them to be charged with the cost of such a sewer as would be sufficient for their purpose, and let any extra size that the surveyor found was requisite be paid for out of the public rates.

It should be noted that in addition to the plans and sections "an estimate of the probable cost" must also be prepared by the surveyor, and this must be very carefully prepared, for it has been held to be a "condition precedent to the recovery of the expenses, that such estimate should have been properly made" (*Vide* 'Fitzgerald' p. 160, 3rd edition).

No mention is however made in the Act of a specification, which is of course absolutely essential.

It may here be of use if I give a specimen form of notice to be served in connection with carrying out the duties involved by this clause; of course each town surveyor must alter the work specified to meet the requirements of the case.

To the Owner or Owners of certain premises fronting, adjoining, or abutting upon a certain street, called in the parish of in the borough of in the county of

Whereas the said street is not levelled, paved, metalled, channeled and made good to the satisfaction of the mayor, aldermen and burgesses of , the urban sanitary authority of the above-named borough:

And whereas your said premises front, adjoin, or abut on certain parts of the said street which requires to be levelled, paved, metalled, channeled and made good as aforesaid:

Now therefore, the mayor, aldermen and burgesses of , the urban sanitary authority of the said borough as aforesaid, hereby give you notice (in pursuance of the statute

in that case made and provided) to level, pave, metal, channel and make good the portion of the said street in which your said premises front, adjoin, or abut as aforesaid, within the space of one month from the date hereof, in manner following that is to say ;

(*If a sewer is to be formed, fill in this first.*)

The carriage-way and water-tables thereof to be formed in the mode, according to the sections, and on the levels and at the rates of inclination shown upon the plan, sections, and in accordance with the specification of the work prepared by the surveyor to the said urban sanitary authority, and now open for public inspection at his office, during the usual office hours.

The carriage-way to be bottomed, formed, and carefully levelled up to the form shown by the said sections ; and in the following manner :

(*Here fill in specification of method.*)

Construct gullies, fitted with five-bar cast-iron gratings and frames of the form and pattern to be seen at , these gullies to be placed in such positions as are shown on the aforesaid plan and sections ; each gully to have a six-inched glazed stoneware socket pipe drain connecting it with the sewer, to be laid on a solid bed, and at an uniform inclination from gully to sewer, with joints made of neat Portland cement.

The existing kerb to be taken up and replaced by inches by inches granite kerb in lengths of not less than inches, to the lines shown on plan, and to the levels marked on sections.

The water-tables or gutter to be channeled with properly laid, and bedded on fine gravel to the levels and inclinations marked on sections.

The footpaths shall be properly formed, bottomed, and

drained where required; the formation level made to the inclination shown on section, and afterwards coated with .

The whole of the above-mentioned works to be executed by you in accordance with the plan and sections hereinbefore referred to and now open for inspection at the surveyor's office as aforesaid, and of the dimensions, widths and levels shown thereon, and to be done in a good workmanlike and substantial manner, to the satisfaction of the said urban sanitary authority and of their surveyor.

An estimate of the probable cost of the said work, prepared under the direction of the surveyor to the said urban sanitary authority, is also lying for inspection at the office of the said surveyor, in manner required by section 150 of the Public Health Act 1875.

Dated this day of 18 .

Town Clerk.

The clause then goes on to say "If such notice is not complied with."

It would be a most difficult and costly proceeding for any individual owner of property to execute the work for half the width of the street opposite his length of frontage, and the result would be anything but satisfactory if the owners of the properties were to comply with the notices in this manner.

If the owners do intend to comply with the notice, and carry out the work themselves, the best method for them to adopt is to hold a meeting and decide upon having it done, then to appoint one of their number, or some other person to superintend or carry out the work, and afterwards collect the money; but this is very seldom done, and the wisest course (which is generally adopted) is not to comply with the notice, but let the urban authority execute the work themselves. This again entails considerable labour upon the town surveyor, who has to superintend the work and see that all the details contained in the statutory notices are properly carried out, but

his labour does not end here. Upon the completion of the work the amount expended has to be recovered "from the owners in default according to the frontage of their respective premises, and in such proportion as is settled by the surveyor of the urban authority, or (in case of dispute) by arbitration."

It is scarcely necessary to point out what an immense amount of responsible work this involves. In the Borough of Portsmouth (where I was engineer for nearly 8 years) separate accounts particularising each item in front of each separate property are prepared, which naturally involves an enormous amount of labour and responsibility upon the officials, as any single item of the account, such as whether a flagstone is new or only redressed, etc., can be, and often is, disputed. This entails a constant supervision being kept over the work and most careful measurements being afterwards made. I am not aware of any other Local Authority where the work is carried out in such minute details, the usual method of procedure being as follows: First, a separate account of all the labour and materials employed on the street must be most carefully kept and totalled at the end of the work, with such additional sum for supervision, &c., as the urban authority may think necessary.* The exact length of each property "fronting, adjoining or abutting" on the street, must be most carefully measured. A proportionate sum has then to be calculated for each of these, and this sum is often complicated by cross roads, cul-de-sacs, narrow passages, strips of land intervening between the street and the properties, and many other perplexing intricacies, in addition to those persons who are legally exempted from any payment under the following clause of the Public Health Act 1875:

"The incumbent or minister of any church, chapel, or place

* In some districts the urban authority make an additional charge of 5 per cent. upon the total outlay to cover the cost of preliminary surveys and supervision of the work by their surveyor; this 5 per cent., however, is not paid to him, but is paid to the city treasurer, and thus becomes a set off against his salary.

appropriated to public religious worship, which is now by law exempt from rates for the relief of the poor, shall not be liable to any expenses under the last preceding section as the owner or occupier of such church, chapel, or place, or of any churchyard or burial ground attached thereto, nor shall any such expenses be deemed to be a charge on such church, chapel or other place, or on such churchyard or burial ground . ." (38 & 39 Vic. c. 55, s. 151).

The town surveyor, having ascertained what is the amount of the sum due from each owner, shall proceed to fill in the amount upon a form, a specimen of which is now given :

To the Owner of certain premises fronting, adjoining or abutting upon a certain street called in the parish of in the borough of in the county of

Whereas the mayor, aldermen and burgesses of the urban sanitary authority for the said , by a notice in writing pursuant to the statute in that behalf made and provided, dated the day of , 18 , required you, being the owner of certain premises fronting, adjoining or abutting upon a street or highway called , within the said (and not being a street or highway repairable by the inhabitants at large) to level, pave, metal, channel and make good the said street or highway within the time and in the manner specified in the said notice, and according to the plans and sections desposited at the office of the surveyor to the said urban sanitary authority at :

And whereas the said notice not having been complied with by you within the time limited by the said notice, the said urban sanitary authority have executed the works mentioned or referred to therein :

And whereas the expenses incurred by the said urban sanitary authority in levelling, paving, metalling, channeling

and making good the said street, amount to pounds shillings and pence:

Wherefore take notice that I the undersigned, being the surveyor of the said urban sanitary authority, in pursuance of the statutes in that case made and provided, do hereby apportion the sum of pounds, shillings and pence as the proportion of the said sum of pounds, shillings and pence, to be paid by you as such owner aforesaid, such apportionment being according to the frontage of your said premises, fronting, adjoining or abutting upon the said street or highway.

Further take notice that the aforesaid apportionment will be binding and conclusive upon you unless within the period of three months from the day of the date of this notice you shall by written notice to the said urban sanitary authority dispute the same.

Dated this day of , 18 .

Surveyor to the said Urban Sanitary Authority.

Clerk of the said Urban Sanitary Authority.

There seems to be no power on the part of any owner to dispute the question as to whether the works carried out have been necessary or not, or whether the cost of the works have been excessive; the only point upon which they can go to arbitration is that as to whether the proportion settled by the surveyor is accurate or not, and this point the arbitrator is left to decide.

It must not be lost sight of that there is a clause in the Public Health Act 1875, which makes the expenses so settled by the surveyor very binding upon the owner of the property in question, unless he appeals within three months from the service of the notice, as the following extract from the clause will show:

. . . "Where such expenses have been settled and appor-

tioned by the surveyor of the local authority as payable by such owner, such apportionment shall be binding and conclusive on such owner, unless within three months from service of notice on him by the local authority or their surveyor of the amount settled by the surveyor to be due from such owner, he shall by written notice dispute the same" . . . (38 & 39 Vic. c. 55, s. 257),* and it must also be borne in mind that the person from whom these expenses may be recovered "is the owner of the premises at the time when the work was done, not the owner to whom notice requiring the work to be done may be given" (*vide* Fitzgerald's Public Health Act, p. 301, 3rd edition); so that the town surveyor must be very careful to make sure that any of the property abutting on the street has not changed hands before he commences the work.

After the 150th section of the Public Health Act has been carried out and a private street has been thus put into thorough repair, the urban authority may take possession of it and declare it to be a highway repairable by the inhabitants at large; the following section of the Act gives the modus operandi necessary to effect this:

"When any street within any urban district, not being a highway repairable by the inhabitants at large, has been sewered, levelled, paved, flagged, metalled, channeled and made good and provided with proper means of lighting to the satisfaction of the urban authority, such authority may if they think fit, by notice in writing put up in any part of the street, declare the same to be a highway, and thereupon the same shall become a highway repairable by the inhabitants at large, and every such notice shall be entered among the proceedings of the urban authority.

"Provided that no such street shall become a highway so repairable if within one month after such notice has been put

* See also 38 & 39 Vict. c. 55, s. 268, where a person who deems himself aggrieved may memoralise the Local Government Board, &c.

up, the proprietor or the majority in number of proprietors of such street, by notice in writing to the urban authority, object thereto, and in ascertaining such majority, joint proprietors shall be reckoned as one proprietor" (38 & 39 Vic. c. 55, s. 152).

The necessary notices in conformity with this section are usually prepared by the town clerk, so that the town surveyor has nothing to do with this proceeding except to maintain the street after it has been declared a highway repairable by the inhabitants at large, in the same manner as he does the rest of the public streets within his district.

There is still one other clause of the Public Health Act 1875 which deals with the question of private roads, and it is as follows:

"Any urban authority may agree with any person for the making of roads within their district for the public use through the lands and at the expense of such person, and may agree that such roads shall become and the same shall accordingly become on completion, highways maintainable and repairable by the inhabitants at large within their district; they may also with the consent of two-thirds of their number agree with such person to pay and may accordingly pay any portion of the expenses of making such roads" (38 & 39 Vic. c. 55, s. 146).

This clause is very explicit and requires no comment; it would however be much better for the urban authority, in contemplating a case of this description, to execute the necessary works themselves and agree with the person about the expense; for if they are intended to be afterwards taken over, it is to be feared that the roads would be very improperly constructed in the first place by the person intending to hand them over. It must be noted that the word "roads" is used in the above clause instead of "streets" as in the other clauses I have quoted, and also that the word "maintainable" is added to repairable.

Street is the term legally used in the Public Health Act 1875, and is thus defined:

"Street includes any highway (not being a turnpike road) and any public bridge (not being a county bridge), and any road, lane, footway, square, court, alley or passage, whether a thoroughfare or not" (38 & 39 Vic. c. 55, s. 4), so that whereas in the 150th section of the Public Health Act 1875, any of the above can be dealt with, it is only open for the urban authority to deal with roads under the 146th section of the Act, and it is sometimes rather difficult to define a road for the purposes of the latter section.

For further information upon this debatable question of dealing with Private Streets under the 150th Section of the Public Health Act 1875, I cannot do better than refer my readers to the footnotes thereon in Glenn's "Law of Public Health," and also to Mr. Spink's paper upon the subject which he read at a District Meeting at Rochester of the Association of Municipal and Sanitary Engineers and Surveyors, in the year 1886. (*Vide* Minutes of Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors, vol. xiii. pages 8 and 111.)

CHAPTER XVIII.

NEW STREETS AND BUILDINGS.

ONE of the most important duties devolving upon a "town surveyor" is that of exercising control over any new streets that may be constructed, or any new buildings that may be erected, within the limits of his jurisdiction.

This duty is in most Towns largely determined by the following section of the Public Health Act, 1875:

"Every urban authority may make byelaws with respect to the following matters; (this is to say,)

"(1.) With respect to the level, width and construction of new streets, and the provisions for the sewerage thereof;

"(2.) With respect to the structure of walls, foundations, roofs, and chimneys of new buildings, for securing stability and the prevention of fires, and for purposes of health;

"(3.) With respect to the sufficiency of the space about buildings to secure a free circulation of air, and with respect to the ventilation of buildings;

"(4.) With respect to the drainage of buildings, to water-closets, earth-closets, privies, ashpits, and cesspools, in connection with buildings, and to the closing of buildings or parts of buildings unfit for human habitation, and to prohibition of their use for such habitation;

"And they may further provide for the observance of such byelaws by enacting therein such provisions as they think necessary as to the giving of notices; as to the deposit of plans and sections by persons intending to lay out streets or to construct buildings; as to inspection by the urban authority, and as to the power of such authority (subject to the provisions of this Act) to remove, alter, or pull down any

work begun or done in contravention of such byelaws. Provided that no byelaw made under this section shall affect any building erected in any place (which at the time of the passing of this Act is included in an urban sanitary district) before the Local Government Acts came into force in such place, or any building erected in any place (which at the time of the passing of this Act is not included in an urban sanitary district) before such place becomes constituted or included in an urban district, or by virtue of any order of the Local Government Board subject to this enactment.

"The provisions of this section, and of the two last preceding sections, shall not apply to buildings belonging to any railway company, and used for the purposes of such railway under any Act of Parliament" (38 & 39 Vic. c. 55, s. 157).

The Powers of the Public Health Act 1875 with respect to new streets and buildings have been further extended by the Public Health Amendment Act 1890 (53 & 54 Vic. c. 59) to which attention has already been drawn. Sec. 23 of Part iii. of this Act is an extension of the powers contained in Sec. 157 of the Public Health Act 1875, which I have quoted above *in extenso.* It must not be forgotten however that these provisions of the Amendment Act 1890 are not in force until they have been "adopted" by the authority under section 3 of the Act.

The result of the above powers having been given by the Act of 1875 to urban authorities is that many of them have framed sets of byelaws, which have received the sanction of the Local Government Board, and are now law in the several districts.

In the year 1877, it being found that considerable variation existed in the requirements set forth in the byelaws, according to the districts from which they emanated, and experience having shown that the forms of byelaws previously issued by the Local Government Board were inadequate, the Local Government Board, in order to assist urban authorities, issued

a series of model byelaws; amongst the series being a set of byelaws regulating the manner in which new streets should be constructed and buildings erected.*

These model byelaws are too extensive to give in detail, as they contain 99 clauses, but every town surveyor should at once procure a copy, even if his corporation have not adopted them, nor intend to do so.

One of the first difficulties that often presents itself to those who have to enforce the observance of the necessary "giving of notices and deposit of plans and sections by persons intending to construct new buildings" is to prove that the building is "new" so as to bring it under the operation of the Act.

In many cases, of course, there can be no doubt; as for instance where bare land is being built upon; but often after buildings have been partially destroyed by fire, or where extensive alterations are being carried out, some considerable elements of uncertainty as to what is a "new building" are introduced.

The Public Health Act 1875 attempts to settle the question as follows:

"For the purposes of this Act, the re-erecting of any building pulled down to, or below the ground floor, or of any frame-building of which only the framework is left down to the ground floor, or the conversion into a dwelling house of any building not originally constructed for human habitation, or the conversion into more than one dwelling house of a building originally constructed as one dwelling house only, shall be considered the erection of a new building" (38 & 39 Vic. c. 55, s. 159).

But the difficulty at once presents itself as to what is meant by the words "ground floor." Does this mean the

* 'Model Byelaws issued by the Local Government Board for the use of Sanitary Authorities. IV. New Streets and Buildings.' Printed by George E. Eyre and William Spottiswoode, 1877.

actual floor level, or the cubical space contained by the walls, floor and ceiling of the "ground floor" (or as it is sometimes called "ground story") of the building? The latter may be fairly assumed to be a correct interpretation, for if we order a man to hang a picture, or to fix a chandelier on the "ground floor," we certainly do not expect to find them placed upon the floor.

It is important that this point should be settled definitely, or some more explanatory term employed in the Act in order to determine what is a new building; for in the present state of uncertainty it may be urged on the one hand that the whole building must be razed to the ground, and on the other that if the more extended meaning of "ground floor" is taken, the removal of the superstructure and destruction of the ceiling only of the "ground floor" would bring the new work under the definition of a new building and within the operation of the byelaws.

This uncertainty is now taken advantage of by builders and others, who sometimes find it irksome and inconvenient to be obliged to construct a building in accordance with the byelaws of any town. Somewhat sharp practices are consequently resorted to in order to evade the law, and old buildings are converted into new ones without any powers of interference by the urban authority or their surveyor. This is greatly to be regretted, as unless the building comes within the operation of the byelaws, it is frequently erected without any sanitary precautions, or even stability.

Sometimes a so-called repair of a building is commenced by adding a new roof, perhaps at a higher level than the old one; when sufficient time has elapsed to allay suspicion, a new front is erected, and then new back and side walls in due course, the alteration of the interior floors not attracting much attention.

Cases of this description are very troublesome to the town surveyor, as if legal proceedings are to be taken against

the offender, it may be requisite for the surveyor to make surveys and drawings of the works as they are in progress in order to prove his case, and these might extend over a considerable period of time.* In order to make these surveys it would be necessary for him to enter the premises whilst the works were in progress; but there does not seem to be any powers conferred on him by any Act of Parliament for such a purpose, as section 305 of the Public Health Act 1875 has been held not to apply, so that really he has no power to prevent the occurrences I have mentioned.

It must also not be forgotten that what may sometimes appear to be an entirely new building, may only be an addition to one that existed before the passing of the Act, and although the new work may be ten times as large as the old, still much conflicting evidence may be brought to bear before it can be proved to be a "new building" within the meaning of the Act. The only help we get from "Glenn," the great authority on all disputed points, is the following remark: "In summary proceedings the question whether an erection is a new building is one of fact for the magistrates." †

Turning again to section 159 of the Public Health Act 1875, these words will be found as defining also what is a

* In the case of an old building being gradually altered into a new one, the following limitation as to proceedings in the Public Health Act 1875 should be noted: "Any complaint or information made or laid in pursuance of this Act shall be made or laid within six months from the time when the matter of such complaint or information respectively arose" . . . (38 & 39 Vic. c. 55, s. 252). The complaint could not be made when the work was first commenced, as no offence would have been committed, and if made after the work was finished, it might be urged that the offence was commenced more than six months prior, and that the complaint should have been made "when the matter of such complaint or information respectively arose." It would be prudent, therefore, for the Surveyor, if he wishes to avoid taking upon himself the responsibility of allowing the work to proceed, to give a warning notice to the builder at the first; and when the alterations have reached a point where, in his judgment, the law has been broken, to commence proceedings by Notice and Summons, based on the assumption that the work done constitutes a 'new building.'

† *Vide* the 'Law of Public Health,' Glenn. Footnote to section 159, page 298, 10th edition.

new building: "or the conversion into a dwelling house of any building not originally constructed for human habitation."

It would have been better in the interests of sanitation if the Act had prohibited the conversion of any building at all into a dwelling house without the approval of the urban authority, for as the law stands at present, it is open for an owner of property to convert stables or warehouses, &c., into dwelling houses, by simply asserting and bringing witnesses or other evidence to prove that they were "originally constructed for human habitation," irrespective of whether they are adapted for the purpose or not, thus defeating the intention of the Public Health Act to secure a better description of dwellings than those that were erected before the passing of the Act; and although this defect is partially remedied by Section 33, Part iii., Public Health Acts Amendment Act 1890, it still does not touch buildings that were erected before the passing of the Public Health Act 1875.

When a dispute does arise with anyone as to whether a building comes within the definition of "new" or not, it is well, if possible, to agree upon certain points of fact and upon plans, &c., before the case comes into court, and then to endeavour to get the magistrates to "view." This course, if pursued, often saves lengthy litigation, and a great waste of time and money.

With reference to the deposit of plans of new streets or buildings, the following clause of the Public Health Act 1875 provides that this shall be done:

"Where a notice, plan or description of any work is required by any byelaw made by an urban authority to be laid before that authority, the urban authority shall, within one month after the same has been delivered or sent to their surveyor or clerk,* signify in writing their approval or disapproval of the intended work to the person proposing to

* Plans are usually deposited with the surveyor, as being the officer who would be most likely to understand them.

execute the same; and if the work is commenced after such notice of disapproval, or before the expiration of such month without such approval, and is in any respect not in conformity with any byelaw of the urban authority, the urban authority may cause so much of the work as has been executed to be pulled down or removed" . . . (38 & 39 Vic. c. 55, s. 158).

The result of these clauses of the Act with reference to new streets and buildings is, that some of the most arduous and irksome duties of the town surveyor are embodied in the few words they contain. These duties consist of, first, the careful examination of, and reporting upon, all plans of new streets and buildings; secondly, the constant supervision of these streets and buildings whilst the works are in progress; and each of these duties will be considered in the course of this chapter.

First then, as to the deposit and examination of the plans of new streets or buildings.

The byelaws of which I have already made mention should contain some such clauses as the following:

"Every person who shall intend to make or lay out any new street, whether the same shall be intended to be used as a public way or not, shall give notice to the urban authority of such intention, by writing delivered to them at their office, or at the office of their surveyor, and shall at the same time leave or cause to be left at the office of the urban authority, or of their surveyor, a plan and section of such intended new street, drawn to a scale of not less than 1 inch to every 44 feet, and shall show on every such plan the names of the owners of the land through or over which such street shall be intended to pass, the level, width, direction, the proposed mode of construction, the proposed name of such intended new street, and its position relatively to the streets nearest thereto; the size and number of the intended building lots, and the proposed sites, height, class, and nature of the

buildings to be erected therein, and the proposed height of the division and fence walls thereon; and the name and address of the person intending to lay out such new street, and he shall himself sign such plan, or cause the same to be signed by his duly authorised agent.

"Such person shall show on every such section the level of the present surface of the ground above some known fixed datum, the level and rate or rates of inclination of the intended new street, the level and inclination of the streets with which it will be connected, and the level of the lowest floors of the intended new buildings.

"Every person who shall intend to erect any new building shall give notice to the urban authority of such intention by writing delivered to them at their office or at the office of their surveyor, and shall at the same time leave or cause to be left at the said office detail plans and sections of every floor of such intended new building, drawn to a scale of not less than 1 inch to every 8 feet, showing the position, form and dimensions of the several parts of such building, and of the water-closet, earth closet, privy, cesspool, ashpit, well, and all other appurtenances; and together with such plans and sections he shall leave or cause to be left at the office of the urban authority, or of their surveyor, a description of the materials of which the building is proposed to be constructed, of the intended mode of drainage, and means of water supply.

"Such person shall at the same time leave or cause to be left at the office of the urban authority, or of their surveyor, a block plan drawn to a scale of not less than 1 inch to every 44 feet, and shall show the position of the buildings and appurtenances of the properties immediately adjoining, the width and level of the street in front, and of the street, if any, at the rear of such building, the level of the lowest floor of such building, and of any yard or ground belonging thereto.

"Such person shall likewise show on such plan the intended lines of drainage of such building, and the intended size, depth and inclination of each drain; and the details of the arrangement proposed to be adopted for the ventilation of the drains."

With reference to the deposit of plans as required by the above byelaw, the following suggestions as to the best manner of effecting this may be of some use:

(1.) The town surveyor should see that the person, or his agent, intending to carry out the work, deposits tracings of the proposed street or building signed by himself, so that there should be no after dispute as to what really has been deposited; these tracings should be on good paper properly inked in and coloured so as to be indelible. In some towns it is the practice for original plans to be deposited temporarily with the surveyor, who is expected to have them traced and then returned to the owner; but this not only tends to the possibility of dispute as to the correctness of the tracings, but it also takes up a large amount of the surveyor's time, or of such other officer as may have charge of this branch of the duties.

In order to insure that the plans deposited shall not be afterwards claimed by the person making the deposit, it might be well to add these words to the clause of the byelaws which I have quoted:

"All such plans and sections so left at the office of the urban authority or of their surveyor, shall remain the property of the urban authority."

(2.) It is advisable for the town surveyor to have in his possession a number of printed forms on which notice should be given by the person intending to erect a new building, and filled in and signed by him or his duly authorised agent. The following is given as a specimen form for this purpose, which can be altered to suit the byelaws in force within the district:

To the Surveyor of the Urban Authority of

I hereby give you notice that it is my intention to erect certain buildings in street, and that the following particulars relate thereto:

No.	Questions.	No.	Answers.
1	Christian and Surname *in full*, Address and Occupation of persons for whom buildings to be erected.	1	
2	Number of drawings deposited.	2	
3	Name of architect, if any.	3	
4	Description of buildings and of the materials to be used in construction of same.	4	
5	Situation of buildings.	5	
6	Level, or intended level of cellar, or ground floor, with reference to surface of street.	6	
7	Thickness of walls.	7	
8	Height of building in stories.	8	
9	Area of clear open space at rear or side of buildings exclusively belonging thereto.	9	
10	Distance across such open space.	10	
11	Description of ventilation.	11	
12	Width of street or open space opposite buildings.	12	
13	Size and description of drains, and traps, and if ventilated.	13	
14	Inclination of drains.	14	
15	Description of outlet to drains.	15	
16	How supplied with water.	16	
17	Situation, dimensions, and particulars of apparatus of W.C.'s.	17	

And I herewith leave detail plans and sections of every

floor of such intended new buildings, drawn to a scale of not less than 1 inch to every 8 feet, showing the position, form, and dimensions of the several parts of such buildings, and of the water-closet, privy, cesspool, earth closet, ashpit, well, and all other appurtenances; and also, a block plan drawn to a scale of not less than 1 inch to every 44 feet, showing the position of the buildings and appurtenances of the properties immediately adjoining, the width and level of the street, the level of the lowest floor of the intended building, and of the yard or ground belonging thereto.

Dated this day of 18

Signature in full,
Address,
Occupation,

A similar form may be prepared relating to plans of proposed new streets, but of course the number of the questions contained in it will be less.

(3.) When the necessary notices have been given and the tracings properly deposited with the surveyor, he should carefully examine them to see if they are in accordance with the enactments and byelaws which are in force in his district. They should then be folded and placed in a large envelope, which should be endorsed with the name of the person proposing to carry out the work, the description of the work proposed, the name of the architect, if any, the name of the builder, if any, the date of the deposit, and a blank left for the date of approval. Each envelope should also have a large number stamped upon it.

(4.) These particulars should be entered in a book of reference against a corresponding number, so that at any future date it may be easy to find and refer to any plans that have been deposited by means of an index and the number on the envelope.

(5.) If on examining the plans the surveyor finds anything

in them which does not conform to the byelaws, it may be well in many cases to return them at once to the person depositing them, without having to wait to lay them before a committee, as this is a great saving of time. In returning the plans the surveyor should write a letter setting forth his objections and the particulars in which the plans and sections fail to comply with the requirements of the byelaws.

(6.) If the plans are redeposited unaltered or showing still some non-compliance with the byelaws, the surveyor must lay them before his committee and explain in what respects they are defective, and the committee can then proceed to formally disapprove of them.

(7.) If the plans are in accordance with the byelaws, the surveyor reports the fact to the committee, whereupon the plans should be approved in writing by the chairman of the committee.

(8.) A notification in writing should be sent to the person who has deposited the plans when they have been approved by the urban authority; and in sending this notification it is well to draw his attention to the fact that notice must be given to the surveyor of the commencement of the work, in order that the foundations, drains, &c., may be examined by him before the ground is filled in.

(9.) All plans which the committee decline to approve of may be returned to the person who deposited them, with a written notification of disapproval.

(10.) Plans which are approved of by the committee and afterwards ratified by the general meeting of the urban authority, should be carefully put away, so that by means of the reference book previously described they can be easily found at any future time.

The importance and necessity for the deposit of plans with a sanitary authority cannot be over-estimated, but this deposit is of but little practical good unless it can be insured that all the buildings are erected strictly in conformity with these

plans, and this is apparently the duty also of the town surveyor, although no mention is made in any of the Acts bearing upon this subject as to whose duty it is to see that the byelaws and other enactments are enforced. As a matter of fact, it is quite impossible for any single person in any large town to perform this duty, and a staff of assistants is consequently necessary if the sanitary authority really wish their byelaws to be enforced.

Anyone who is practically acquainted with the difficulties that even architects experience in superintending buildings they have *themselves* designed, and how much they have to trust to the clerk of works (of which there is generally one to every building), will readily see what an absurdity it is to suppose that a town surveyor, with his multitude of other duties and attendances at committees and meetings, can even pretend to see that the 99 detail clauses of such byelaws as those emanating from the Local Government Board Office, or even those of a less stringent character, can possibly be enforced; especially when it is remembered that many of the buildings he has to inspect have no superintending architect, but are being erected for purposes of speculation by small builders, who design and carry out their own work.

Laws may be passed, books on sanitary questions may be written, but unless a large staff of inspectors or sanitary police or some such officials are kept by a sanitary authority, very little real advancement will be made with the poorer classes of buildings.

It must in fairness to the builder be stated that to erect houses in strict accordance with the *model* byelaws would probably mean loss of money to him, as they could not possibly be built with any prospects of a reasonable return upon the outlay, unless much higher rents were charged than can usually be paid by the class who occupy them. This partly arises from the stringent clauses inserted with respect to the structure of walls and other precautions for the pre-

vention of fires.* I cannot help thinking that too much interference is now made by sanitary authorities for the protection of property from fire. It is not a sanitary question, and is certainly one which chiefly affects insurance companies. Every one should be able to pay his small insurance premium, and the companies should look after their own interests, and not expect it to be done by others. If the sanitary authority wish to interfere in the question of fire why should not the protection of *life* be considered as much as *property*. Yet no clause can be discovered in the model byelaws rendering it compulsory to make some provision in dwelling-houses or factories for the easy escape of the inmates in case of fire. Indeed, as the Public Health Act does not authorise the enactment of a byelaw for such a purpose, such a clause would most probably be held to be *ultra vires*.

Another cause of expense to builders is the necessity imposed on them to provide a comparatively large open space at the back or sides of new dwelling-houses, thus sacrificing land, and sometimes making it almost impossible to build at all. This requirement of open gardens or yards at the back of even small labourer's dwellings is in some towns pushed to an extreme. If such houses are erected in a thoroughly sanitary manner in all points of detail, it is questionable if a large open space is really beneficial. My experience has shown me that this space is often misused; animals, such as rabbits, chickens, pigeons, &c., being kept there; or it is made into a so-called garden, really a refuse heap which is a receptacle for all the garbage and filth of the house, soon becoming a fruitful source of disease to the occupants of the house itself and the neighbours. It is also difficult to ensure,

* Nothing can be more vexatious than the byelaw compelling the party-walls of new buildings to be carried up above the roof to at least twelve inches; not only does this frequently spoil the architectural appearance of a building, but it causes great expense in order to keep the wet out: a very difficult thing with a wall treated in this manner.

without a considerable amount of inspection, that the space thus provided and approved of in the deposited plans shall not be built upon at some future period without the consent of the local authority. It would be better if the streets in front of such dwellings were wide, and a narrow street or passage constructed at the back for the dust-cart service supply of coals, &c. The houses themselves should have their rooms properly and thoroughly ventilated; underground kitchens or living rooms should be prohibited. The drainage, water-supply, and all the apparatus in connection with them, should be perfect but simple. At the back of the house should be a small yard or court well paved with asphalte or other impervious material, in which should be placed the wash-house, W.C., &c. These, and public parks, and plenty of fresh air in the streets and in the dwelling-houses themselves, should take the place of the large open spaces at the back of small dwelling-houses, which, as I have already stated, are generally so much misused.

The model byelaws with regard to new streets and buildings issued by the Local Government Board contain most admirable clauses—valuable suggestions which should receive attention from any town surveyor who has to advise his corporation upon the subject of framing a set of byelaws for his district—but they necessarily contain many clauses which are not suitable equally well for towns in the north, south, east, and west of England.

Many of the clauses are too stringent to be enforced, but this arises not from any fault in the byelaws themselves, but rather from the machinery employed in carrying them into effect. To secure all that they require, adequate inspection is needed, and this might be effected if there was a fee charged by the urban authority of any town for the purposes of proper inspection of buildings in course of construction; and although it must be admitted that any provision which increases the cost of construction of small dwelling-houses which shall be

complete in all sanitary requisites is undesirable, the extra cost of such inspection would be too small to be appreciable, while the advantages arising from such improved supervision would, even from a pecuniary point of view, be of immense advantage not only to the community as tending to improve the public health, but also to the owner as ensuring good honest work in return for his money. In larger and more expensive buildings this supervision is exercised by the architect, but as a rule there is no architect employed in the case of small houses, and the builder is accordingly left to his own devices, with frequently unfortunate results.

CHAPTER XIX.

SCAVENGING.

IN a great number of towns in this country the town surveyor has charge of the unostentatious, though very necessary, sanitary work of the scavenging of the district over which he has charge,* and the following are the clauses of the Public Health Act 1875 under which he carries out his duties:

"Every local authority may, and when required by order of the Local Government Board shall, themselves undertake or contract for—

"The removal of house refuse from premises:

"The cleansing of earth closets, privies, ashpits, and cesspools;

either for the whole or any part of their district: Moreover every urban authority and any rural authority invested by the Local Government Board with the requisite powers may, and when required by the said board shall, themselves undertake or contract for the proper cleansing of streets, and may also themselves undertake or contract for the proper watering of streets for the whole or any part of their district.

"All matters collected by the local authority or contractor in pursuance of this section may be sold or otherwise disposed of, and any profits thus made by an urban authority shall be

* Sir Robert Rawlinson, when speaking at a district meeting of the Association of Municipal and Sanitary Engineers and Surveyors at Stratford-on-Avon, said, "There is one thing that I wish to say to the governing people of Stratford-on-Avon, "and that is, that the foundation of all sanitary science is scavenging; and if I "were asked what is the most important feature in sanitary science, I would "repeat again, scavenging. Your sewers, your drains and water supply are all "secondary considerations if scavenging is neglected."

(*Vide* Minutes of 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. xii. page 64.)

carried to the account of the fund or rate applicable by them for the general purposes of this Act; and any profits thus made by a rural authority in respect of any contributory place shall be carried to the account of the fund or rate out of which expenses incurred under this section by that authority in such contributory place are defrayed.

"If any person removes or obstructs the local authority or contractor in removing any matters by this section authorised to be removed by the local authority, he shall for each offence be liable to a penalty not exceeding five pounds: Provided that the occupier of the house within the district shall not be liable to such penalty in respect of any such matters which are produced on his own premises and are intended to be removed for sale or for his own use, and are in the meantime kept so as not to be a nuisance" (38 & 39 Vic. c. 55, s. 42).

The next clause imposes a penalty on the local authority if they fail "without reasonable excuse after notice in writing from the occupier of any house" to cleanse the ashpit, &c., within seven days if they have "themselves undertaken or contracted for the removal of house refuse," &c., and the next clause is as follows:

"Where the local authority do not themselves undertake or contract for:

"The cleansing of footways and pavements adjoining any premises;

"The removal of house refuse from any premises;

"The cleansing of earth closets, privies, ashpits, and cesspools belonging to any premises;

"They may make byelaws imposing the duty of such cleansing or removal, at such intervals as they think fit, on the occupier of any such premises.

"An urban authority* may also make byelaws for the prevention of nuisances arising from snow, filth, dust, ashes

* A *rural authority* cannot apparently make any byelaw with regard to the prevention of such nuisances.

and rubbish, and for the prevention of the keeping of animals on any premises so as to be injurious to health"* (38 & 39 Vic. c. 55, s. 44).

There is also another clause in the Public Health Act 1875, which is as follows:

"Any urban authority may, if they see fit, provide in proper and convenient situations receptacles for the temporary deposit and collection of dust, ashes, and rubbish; they may also provide fit buildings and places for the deposit of any matters collected by them in pursuance of this part of this Act" (38 & 39 Vic. c. 55, s. 45).

The result of the above comprehensive clauses upon the subject of scavenging is that the following duties fall upon the town surveyor where that officer is responsible for such work:

(1.) "The removal of house refuse from premises."

This work, like all the rest which follows, can be done either by the local authority themselves or by contract, the former method, as I hope presently to show, being much the best system.

In connection with this first duty of the removal of house refuse, the following points will have to be considered:

(*a.*) What is house refuse?

(*b.*) What is the best manner of storing it on the premises pending the visit of the scavenger?

(*c.*) Which are the best methods for its collection?

(*d.*) Which are the best methods for its disposal?

(2.) "The cleansing of earth closets, privies, ashpits, and cesspools."

This work where necessary (owing to the want of a

* A byelaw under this section "must be limited to imposing upon the occupier the duty of cleansing or removal at such intervals as the sanitary authority may think fit. The mode of cleansing or removal and the precautions to be observed in connection with the process are not matters within the range of such byelaws." *Vide* 'Memorandum to the Model Byelaws issued by the Local Government Board for the use of Sanitary Authorities, No. 1, Cleansing of Footways and Pavements, &c.,' 1778.

system of sewerage) can be carried out simultaneously with the collection of house refuse and in almost the same manner.

(3.) "The proper cleansing of streets."

In connection with this duty the following points must be considered:

(*a.*) The best methods for sweeping and cleansing streets.

(*b.*) If machinery effects such work better and more economically than hand labour.

(*c.*) The extra work involved by the bad construction of streets, or the ill chosen materials of which they are formed.

(*d.*) Whether private streets, courts and alleys, "not repairable by the inhabitants at large," should be swept and cleansed by the local authority?

(*e.*) The ultimate disposal of excessive accumulations of mud.

(*f.*) The removal and disposal of snow.

(4.) "The proper watering of streets for the whole or any part of their district."

In considering this question it is necessary to note:

(*a.*) The best form of vehicle for carrying and spreading the water.

(*b.*) The number, position, and description of standpipes.

(*c.*) Whether vehicles, or fixed standpipes and hose are best.

(5.) If the local authority do not impose a byelaw they must themselves cleanse the "footways and pavements adjoining any premises;" and this in excessively muddy weather, or after a heavy fall of snow, is no inconsiderable work.

(6.) An *urban authority* may make provision for the "temporary deposit and collection of dust, ashes and rubbish."

This involves public dust-bins being placed in suitable positions in the town, the points in connection with this work being,

(*a.*) The most suitable sites for such accommodation.

(*b.*) The materials and form of which they shall be constructed.

Having thus stated all the heads under which the work of scavenging may be grouped, it is necessary to decide what is "house refuse;" for unless this is satisfactorily settled, considerable onus and expense will be put upon the local authority if they are to include in the removal trade, garden, and other similar refuse.*

It may be assumed that all house refuse which it is the duty of the scavenger to remove, is really so removed by the direction of the local authority without dispute, but that the following articles, which frequently find their way into a domestic dust-bin, are not in the strict terms of the Act expected to be removed by him. (1) Plaster from walls and brick bats, (2) Large quantities of broken bottles and flower-pots, (3) Clinkers and ashes from foundries and green-houses, (4) Wall paper torn from the rooms of a house, (5) Scrap tin (but not old tins which have contained meats, &c., and which, although very useless and bulky, may be fairly assumed to be house refuse), (6) All garden refuse such as grass cuttings, dead leaves, and the loppings from trees and shrubs.†

As a matter of fact, out of ninety towns with which I communicated on this subject, only thirteen of them directed

* In Glenn's 'Law of Public Health and Local Government,' 10th edition, in a footnote to section 43, p. 86, under a sub-heading 'Meaning of Refuse,' several cases are cited to illustrate what substances may *not* be considered refuse within the meaning of the Act, but no attempt is made to define what *is* refuse.

† The Bromley Local Board issue a card on which is printed, amongst other information with reference to the contract for the removal of house refuse, the following suggestions:—"It is hoped that householders will as far as possible facilitate the systematic removal of refuse by providing suitable dust-bins, and directing their servants that ordinary house refuse only shall be deposited in such receptacles. The following are some of the items of refuse which the contractors are bound to remove, viz.:—cinder ashes, potatoe peelings, cabbage leaves, and kitchen refuse generally. But the contractors are not required to remove the refuse of any trade, manufacture, or business, or of any building materials or any garden cuttings or sweepings."

the removal of both trade and garden refuse without any special extra payment being made by the householder, and this is only done when these materials are placed in the ordinary dustbin or ashpit attached to a house. Several towns, however, it appears, remove such materials on special payments being made of sums varying from 1*s.* 6*d.* to 3*s.* per load.

Disputes frequently arise between the men employed in scavenging and the householder on these vexed questions as to the difference between house, trade or garden refuse: a dispute often raised by the scavengers themselves, in the hope of containing a gratuity or reward for the clearance of a dust-bin, which no doubt, legally, they are perfectly justified in refusing to empty; and in order to lessen the chance of such disputes and to attempt to settle this question, the following suggestions may be of value.

It would no doubt be vexatious if any sanitary authority were to absolutely refuse to remove the "garden" refuse from those houses to which a small flower garden was attached; whilst it would on the contrary be an unfair tax upon the general community if the refuse of large gardens was removed without payment. A good rule would therefore be to remove only such *garden* refuse as was contained in the ordinary dustbin or ashpit attached to a house, and that as the removal of any kind of *trade* refuse would no doubt lead to abuses if done gratuitously by the sanitary authority, that this material should only be removed on payment of some sum, which should be previously fixed by the local authority, and each case should be reported to the officer superintending the work before it was removed.

The next question is the important one of the manner and place in which house refuse shall be temporarily stored pending the visit of the scavenger.

The Public Health Act of 1875 enacts that: "Every local authority shall provide that all drains, water-closets, earth

closets, privies, ashpits,* and cesspools within their district be constructed and kept so as not to be a nuisance or injurious to health" (38 & 39 Vic. c. 55, s. 40).

And section 35 of the above Acts states, "It shall not be lawful newly to erect any house or to rebuild any house pulled down to or below the ground floor without a sufficient water-closet, earth closet, privy, and an ashpit furnished with proper doors and coverings. Any person who causes any house to be erected or rebuilt in contravention of this enactment shall be liable to a penalty not exceeding twenty pounds" (38 & 39 Vic. c. 55, s. 35).

The same Act also gives power to local authorities to enforce provision of ashpit accommodation for houses where such accommodation does not already exist, and to frame bye-laws with respect to ashpits.

There can be no doubt that the position of the dustbin or ashpits, as regards its site with reference to the main dwelling-house, is of primary sanitary importance, for if the garbage and domestic accumulations therein are allowed to remain for a few days, especially when the weather is close, damp, and warm, they become very offensive, and the emanations therefrom may even be highly deleterious and dangerous to health; this effect is aggravated by persons emptying vegetable refuse and other matters which are *wet* into the dustbin, as decomposition of these matters is greatly assisted by this addition; and it would be well that all such matters should be burnt on the kitchen or scullery fire along with a large percentage of the ashes which could be sifted and saved from those which too readily find their way into the dustbin, and are thus wasted. Care would of course have to be taken in this process that no smell or nuisance was caused by the process of burning.

It is open to considerable doubt if the fixed dustbin or

* The expression 'ashpit' in the Public Health Acts and in this Act shall for the purposes of the execution of those Acts and of this Act include any ashtub or other receptacle for the deposit of ashes, fæcal matter, or refuse. (53 & 54 Vict. c. 59, section 11, sub-section 1.)

ashpit is the best or most sanitary receptable for the houee refuse; they may be necessary and suitable for Public Institutions, or for large isolated private dwellings, or for schools or any places where excessive quantities of refuse may accumulate; but where this refuse is systematically and properly removed by the order of the local authority, at such times and in such manner as will be hereafter pointed out, moveable or portable dustbins, boxes or baskets are far preferable to the large immoveable, inconvenient fixed ashpit, recommended and enforced under the Act.*

The next point to consider is that of the collection of the house refuse, which should be effected satisfactorily, economically and expeditiously.

The following are the three methods by which this is attempted:

(1.) By a house-to-house call at intermittent periods.

(2.) By the scavengers giving notice of their approach by ringing a bell, or by other signal, and requiring the householder to bring out the refuse to the cart.

(3.) By placing public dustbins in different localities, and expecting householders in their vicinity to place the house refuse in these dustbins, which are then cleared from time to time by the local authority.

Experience alone can teach which of these is the best method to adopt in any district, and it is usually found that some modification of all three is necessary.

It is, however, difficult sometimes to adopt public dustbins, not only on account of their first cost, but from the objections raised by the occupiers of adjacent houses to their being fixed in their neighbourhood.

If these dustbins were constructed with properly balanced self-closing lids, these objections might be overcome, and

* The large open ashpit is especially to be avoided; in districts where these are plentiful it is surprising what a large area of ground they collectively cover, and their effect upon the surrounding air especially under certain conditions of the atmosphere cannot but be detrimental to the health of the inhabitants.

their first cost would be but trifling when compared with the benefit to be derived by placing them in some of the thickly populated courts and alleys which are unfortunately to be found in nearly every town. Where there are no public dustbins the inhabitants of these courts throw their waste products upon the surface of the streets or courts, from time to time throughout the day, as it cannot be expected nor desired that such materials should remain, even for twenty-four hours, in their one living room, which is frequently over-crowded, and has but little spare space even for the common necessities of life; but that these waste products should be thus strewn over the surface of the street or court is almost equally objectionable, and points to the advantage to be gained by placing in convenient situations covered dustbins which could be easily emptied once a day.

Undoubtedly the best method for the removal of refuse is the house-to-house call; but except in suburban districts and for the collection of refuse from the better class of dwelling-houses and public institutions, the expense, delay and difficulty which would be incurred in calling at every house throughout a town, would make it almost impracticable, and consequently this system is universally combined with that which is known as the bell or signal system, which simply means that the scavenging cart in going its rounds has a bell attached to it, or the horse, which bell rings automatically as the cart proceeds on its way; or the man in charge blows a trumpet, or calls in stentorian tones, "Dust oh!" On hearing this signal, *but not before*, the householder is expected to bring out the refuse in some convenient receptacle, which is then emptied into the cart by the scavenger.

As a matter of fact, the receptacles containing all the waste products of these householders are brought out and are placed in the gutter of the street close to the kerb, long before the cart makes its appearance or can be reasonably expected to do so.

The result of these (generally inappropriate) receptacles filled with heterogeneous collections of house refuse being left unprotected in the public streets, is that their contents are quickly strewn about the surface of the street, by their being upset accidentally, or purposely, and the appearance of the street, which has probably been carefully swept and garnished during the night or early in the morning, quickly assumes, especially in a high wind, a very offensive character, and probably has to be entirely re-swept and cleansed before the ordinary traffic of the day commences.

The "house-to-house" call system in the suburbs of a town may be greatly assisted by a very simple remedy, which has already been tried in some towns with considerable success. It consists in the householder placing a card bearing the letter D, or some other distinguishing mark, in a conspicuous place in a window, when the services of the scavengers are required; these cards should be printed and circulated by the Sanitary Authority of the district, who should state on the back of the card the days on which the scavengers would visit each neighbourhood, with the approximate hour of the day in which they would appear, in order that the householder may not be unnecessarily inconvenienced by being obliged to keep the card for any length of time in his window.

The scavengers in passing observe the signal, and call at the house; otherwise they pass on, unless specially called in by the occupants, thus avoiding any unnecessary delay in their rounds.

A visit from the scavengers either before seven or after ten in the morning is generally very inconvenient for households of a superior class, and should be, if possible, carefully avoided by the sanitary authority.*

* Where a local authority themselves undertake or contract for the removal of house refuse, they may make byelaws imposing on the occupier of any premises duties in connexion with such removal so as to facilitate the work which the local authority undertake or contract for. (53 & 54 Vict. c. 59, section 26, sub-section 2.)

The cart usually employed for scavenging is that known as the ordinary "tip cart," strongly, if not clumsily, constructed of an oak frame, with elm or deal sides of considerable height; it holds about a couple of cubic yards of material, and costs from sixteen to twenty pounds.

I will not in this edition detail the many objections which pertain to this description of dust-cart, but merely say that with a view to obviate these and other objections, several improved carts and waggons have been introduced by different makers, who have styled them by a variety of names, and which no doubt are now thoroughly well known to my readers.

With reference to the important question of the ultimate disposal of house refuse, street sweepings, &c., no rules can be laid down, as so much depends upon the position of every town and the character of the district in which it is situated. This is evidenced by the replies which I received in answer to some questions upon the subject which I addressed to several English towns some years ago.

In many towns it was stated that the whole of the refuse was used by brick makers, in others it was simply "tipped to waste." In one case the answer was "Sold by auction twice a year," but to whom it was sold, and for what purpose, did not transpire. In some towns it appeared to have been mixed with lime and used as manure upon the fields, and in others it was mixed with the sludge of the sewage farms, and was then ploughed or dug into the soil of the farm. This seems a better plan than that of another town, where it was "given or thrown away," although the difficulty of disposing of the old iron, tins, &c., is not touched upon in any of the foregoing answers. The next reply states that "it is riddled, and the cinders and vegetable refuse are burnt to generate steam, the fine dust is used with the manure manufactory (tub system), the old iron is sold, and the pots, &c., used for the foundations of roads." In one case the whole of the refuse was taken out

to sea in hopper barges, and sunk in deep water.* In a great number of towns it was sold by tender for the year, but what eventually became of it did not transpire. But the most favoured methods, where it could not be sold as manure to farmers, seemed to be either that of carting it away to some spot outside the town, and there using it for the purpose of filling up hollows and depressions, or that of giving or selling it to brick-makers.

The practice of filling up hollow places with such materials cannot be too strongly deprecated if there is any chance of dwelling houses being erected on them, as the unsanitary condition of sites thus formed has been frequently demonstrated.

With reference to this practice the Public Health Amendment Act 1890, to which allusion has been previously made, enacts as follows:

"It shall not be lawful to erect a new building on any ground which has been filled up with any matter impregnated with fœcal animal, or vegetable matter, or upon which any such matter has been deposited, unless and until such matter shall have been properly removed by excavation or otherwise, or shall have been rendered or have become innocuous.

Every person who does or causes, or wilfully permits to be done any act in contravention of this section shall for every such offence be liable to a penalty not exceeding five pounds, and a daily penalty not exceeding forty shillings" (53 & 54 Vic. c. 59, s. 25).

The difficulties thus experienced in attempting to dispose of all scavenging material in an economical and sanitary manner led to attempts being made to destroy all such matters by the aid of fire, such attempts having been made by Messrs. Meade and Co. so long ago as the year 1870. Since then many efforts have been made to solve the problem, and

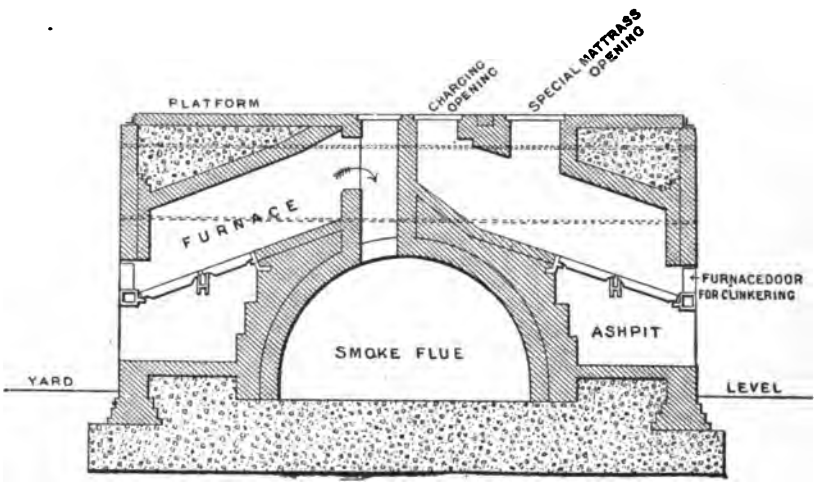
* In New York about 800,000 tons of refuse are disposed of annually in this manner, and in Liverpool 160,000 tons of refuse are similarly disposed of annually.

the following names are those of some of the gentlemen who have given considerable attention to the subject:

Birtwistle, Burton, Fryer, Hardie, Healey, Heard, Horsfall, Jacobs, Jones, Lupton, Manlove, Ogden, Pearse, Pearson, Pickard, Richmond, Sergeant, Stafford, Thwaites, Wilkinson, Whiley, Young.

The destructor, however, which is best known to Surveyors, and which has been generally erected in this country, is that which is called "Fryer's destructor," and which may be shortly described as follows:—

The destructor consists of a number of cells or furnaces so constructed together that, although each cell is independent



SECTION OF A FRYER'S DESTRUCTOR.

of the other and performs its own duty, the products of combustion therefrom pass into a chamber or flue common to them all, and thence to the chimney shaft.

Each cell has a separate feeding hopper on the top for the purpose of charging it with the refuse, and a furnace door for the withdrawal of the clinker.

Each cell is about 9 feet long and 5 feet wide, covered by a firebrick arch 3 feet 6 inches high. The furnace has an in-

clination of one in three from back to front to facilitate feeding and clinkering. On one side of the furnace is the opening for the admission of refuse and on the other is an opening to the flue. As the refuse to be burned has to be taken to the top of the cells, it is necessary to construct an inclined way or road, up which the carts can be drawn, the gradient of which should not if possible exceed 1 in 15.

With regard to the cost of the erection of refuse destructors it naturally varies considerably, as so much depends upon cost and preparation of site, height of chimney, foundations, access to top of destructor, value of materials, wages, etc., as the following table will shew.

Name of Town.	Number of Cells.	Height of Chimney.	Weight of refuse destroyed in 24 hours in Tons.	Cost.
				£
Blackburn	4	105	24	2,106
Bolton	8	180	50	9,200
Bournemouth	4	137	26	3,000
Bradford	12	180	74	11,892
Bury	4	180	20	3,500
Buxton	2	145	12	1,835
Derby	6	160	50	9,544
Ealing	4	143	50	2,000
Heckmondwike	3	120	18	1,512
Hull	6	180	14*	3,100
Leeds	10	120	120	7,466
	10	150		7,282
Newcastle-on-Tyne	6	150	30	5,015
Nottingham	6	160	100†	6,361
Preston	8	180	32	4,121
Salford	6	180	28	2,400
Southampton	6	160	30	3,300
Wandsworth	12	180		6,613
Whitechapel	8	180	60	12,691

It will be seen by the above table that the average height of the chimney shafts is 157 feet, and that the cost of construction per cell is 823*l.*

If, however, all cost of land, fences, walls and buildings

* Cells not fully worked.
† This return is remarkable.

be excluded, the approximate cost of a six-cell destructor, with a chimney shaft 160 feet in height, should be about 3500*l.*

With regard to the question of the amount of refuse which can be destroyed by burning, the average of the above table, excluding Nottingham, is about 6 tons per cell per twenty-four hours, and this may be assumed as a fair average. The cost of this work varies considerably with the nature of the material to be consumed; for instance, the following are the percentages of water contained in house refuse in the Towns enumerated:—

Bradford,	House Refuse	contains	47	per cent.	of	water
Leeds	,,	,,	39	,,	,,	,,
Whitechapel	,,	,,	29	,,	,,	,,
Ealing	,,	,,	75	,,	,,	,,

This latter being mixed with sewage sludge before being burnt.

The following table gives some interesting particulars with regard to the cost of destruction, including labour, interest on and repayment of capital, and general expenses, etc.:—

	s.	*d.*		
Batley		6	per	ton
Bradford		9¾	,,	,,
Bury	1	10¼	,,	,,
Ealing		9	,,	,,
Heckmondwike	1	10	,,	,,
Hull	1	2	,,	,,
Leeds		10¼	,,	,,
Newcastle-on-Tyne	1	0	,,	,,
Salford	1	6	,,	,,
Southampton		7	,,	,,
Warrington		10	,,	,,
Whitechapel	2	3	,,	,,

Or an average (excluding Whitechapel) of 1*s.* 0¾*d.* per ton.

In burning the refuse great care must be observed in feeding the cells and in the removal of the fine ash and clinker, as, unless a very high temperature is maintained, the vapours

of distillation (or empyreumatic vapours as they are scientifically termed) will be given off.

If the draught is too great, dust or small particles of unconsumed refuse will be carried up the chimney and cause a great nuisance, and it was to avoid this that Mr. Jones the surveyor to the Ealing Local Board introduced his well-known Fume Cremator, by which all the products of the combustion of the refuse are carried over a bright fire and are thus rendered harmless, at the same time that the draught is improved by this method.

Experiments which were made in connection with this invention gave the following heats of the vapour:—

Temperature in the Flue	610°	Fahrenheit
,, in the Fume Cremator	1270°	,,
,, after leaving Fume Cremator	1100°	,,

"At these temperatures, and in presence of the accompanying air,* all septic poisons are destroyed, and organic compounds resolved into carbonic acid, water, and nitrogen gas, only the minutest traces of empyreumatic products could survive and pass into the atmosphere. No harm to the health of the community is to be expected or feared from these products." †

The heat thus developed can be employed in a variety of ways, the usual method is to fix a multitubular boiler in a direct line of the flue on the chimney side of the fume cremator, where sufficient heat can be obtained to generate steam up to as much as 12 h.p. per cell, although the average must not be taken higher than 6 h.p. per cell in winter, and 3 h.p. in summer, the variation being caused by the fact that in the former time of year there are more cinders and coal in the house refuse, whereas in the summer time there is a preponderance of green vegetable refuse.

* Each cell takes about 13 tons of air to burn 1 ton of refuse.

† *Vide* 'Destructors and Refuse Furnaces,' by W. Warner. A lecture delivered before the members of the Yorkshire Association of Sanitary Inspectors at Bradford, 1888.

The clinker and fine ash that remains after the house refuse has been burnt varies considerably with its character; in some cases the two combined are only 15 per cent. of the refuse destroyed, whilst in others they reach 33 per cent., where crockery, tins, and other hardware are largely mixed with the refuse.

Of these waste products the clinkers may be advantageously used as follows:—

Hard core for roads and footpaths, ballast for railways, under-pinning of second class paved streets, filling up vacant land or disused quarries, mixed with lime and made into mortar, ordinary concrete for foundations, ground with cement and made into artificial stone either as paving slabs or for house building, tar paving, and many other purposes.

The fine ash may be used for bedding setts instead of sand, made into plaster or mortar, mixed with night soil, sold direct to farmers, or in some cases used instead of gravel for suburban footpaths.

Another method for the disposal of house refuse, which has been experimentally adopted (only 35 loads a day being dealt with) is that of mechanically sorting the refuse and utilizing the materials in the following manner:—paper and rags for paper-making, straw, etc., for fuel, tins for scrap, bottles for refuse, bones, ashes and breeze for manure, glass for melting, iron for scrap, other refuse and rubbish for grinding and mixing with dust. This work is carried out at Salopian Wharf, Lots Road, Chelsea, by the Refuse Disposal Company.

Whilst this edition was in the press, Mr. Price, the surveyor to the Local Board of Toxteth Park, prepared a return dealing with the replies he had received to some questions he had caused to be issued to a great many towns in connection with the questions of the collection and disposal of house refuse, and it may be interesting to note the following particulars in connection therewith. As to the collection of

refuse, out of 85 towns from which replies were received, 70 executed the work with their own staff, two executed it partly with their own staff and partly with the assistance of a contractor, and only 13 executed the work by contract. The number of carts or vans engaged upon the work averaged ·006 per acre of the area of the towns; but whether this represented the area of the district scavenged is not apparent. The shortest periods which were allowed to clapse between each emptying of the ashpits was "part daily and part once a week," and the longest six months. The amount of refuse per head of population collected per annum works out at 0·39 of a ton, and the average cost of this work at per head of the population is 1*s.* 6¾*d.*

With regard to the disposal of the Refuse, out of 81 towns replying, 35 destroy by fire, the chief points of interest being as follows:—

The average cost of construction of the destructors amounts to 525*l.* per cell. The average number of tons consumed per diem per cell equals 6 tons. The average number of men employed per cell equals 1·17. The average annual cost per cell equals 96*l.* The average height of chimney is 163 feet, costing an average of 6*l.* 3*s.* 4*d.* per foot to erect. The average cost of destruction of the refuse amounted to 11½*d.* per ton.

The next point which has to be considered, and which is the second in order of the list of duties I have given at the commencement of this chapter, is "the cleansing of earth closets, privies, ash-pits, and cesspools."

This is generally effected in conjunction with the collection of the house refuse, and the work is carried out at night. Under the Goux-tub system the ashes of the house refuse are largely used as a deodorant or absorbent as a lining for the tub,* but in the pail systems this mixture is not effected until the tubs and refuse arrive together at the depot.

* The ashes are mixed with chaff, chopped straw, refuse hay, grass cuttings, dry street sweepings, wool and hair shoddy, &c., and a small percentage of sulphate of iron or lime.

The next duty which has to be considered is that of "the proper cleansing of streets."

There is no doubt that, for the sake of the appearance as well as the health of any town, its streets cannot be too well cleansed. Muddy and wet streets cause dampness in the subsoil of neighbouring dwellings, and dust is not only injurious to tradesmen's goods, but also to the lungs of those who have to breathe an atmosphere loaded with silicate and organic impurities.*

Street cleansing is effected either by hand-sweeping and hand-scraping, or by machinery. As to which is the most economical much depends upon the value of labour, and also upon the condition of the roads to be dealt with; but in point of time, and as a general rule, the value of a horse rotary brush-sweeping machine is undoubted; the only time at which such a machine fails to do effective work on a macadam road is on the occasions when the mud to be removed (owing to a peculiar condition of the atmosphere) has attained a semi-solidity, and is of a stiff and sticky consistency, when it either adheres to and clogs the brushes of the machine, or is flattened by them on to the road instead of being removed.†

The brushes of a machine last about 180 hours continuous work, and then the old stocks can be easily refilled with bass at no great cost. The comparative work which can be done by a sweeping machine is about 11 to 1 of that effected by manual labour, so that the economy evolved by the former method is evident.

* Professor Tyndall, in his beautiful experiments, has proved that dusty air is alive with the germs of the bacteria of putrefaction, whilst the pure fresh air which he gathered on a mountain peak in the Alps is innocent of such germs, and is absolutely powerless to produce any organisms.

† Dry dust will absorb about ten times its bulk of water, thus swelling considerably and producing the greasy mud so often seen after rain.

Dr. Letheby's analysis of street sweepings which he made in 1867 is as follows:—

Dry dust	.. ..	58·2 per cent.	organic matter
,, ,,	.. ..	41·8 ,, ,,	mineral ,,
Wet Mud	.. ..	20·5 ,, ,,	organic ,,
,, ,,	.. ..	79·5 ,, ,,	mineral ,,

On the question of the extra work involved in street cleansing by its bad construction or by the materials of which it is constructed, climate must be considered, as well as the amount of traffic it has to bear, and also its gradient and the habits of the people residing in it.*

The Superintendent of the Scavenging Department at Liverpool has made some observations and obtained some valuable information on these points, which he has detailed in a report he presented to the Health Committee of that borough in the year 1877, an abstract of which is given on the next page.

He adds that the full benefit of the impervious pavements as regards the cost of scavenging has not yet been felt, for almost all the lines of streets so paved are intersected at short distances by streets of ordinary jointed granite setts or macadam, whence a quantity of mud and refuse is dragged by the traffic on to the asphalted jointed roadways, which are consequently debited with the cost of removal of some effete material not intrinsically belonging to them.

Mr. Till, the Borough Surveyor of Birmingham, from investigations he has made on this subject, says that for granite pavement 2 cart-loads of mud have to be removed from every 1000 square yards of surface, one-third of a load for wood pavement † and 4 loads three times a day (a total of 12 loads) for macadamised roadways.

The ultimate disposal of the material removed from the surfaces of roadways, especially when they are macadamised, is a difficult matter, as, being chiefly composed of silicate, it is valueless as a manure.

In small towns, except during abnormally muddy weather,

* In Boston, U.S.A., the macadamised roads are not swept at all, as it is considered that by sweeping off the sand and detritus their durability is much lessened, but their gutters are cleansed as required, and rubbish picked up. *Vide* 'Minutes of Proceedings Institution of Civil Engineers,' vol. lxiii. p. 368.

† In Regent Street, London, in November 1881, I saw four loads of mud removed from about 1000 square yards of surface, it being then almost new wood pavement.

GROSS COST FOR EACH TIME OF CLEANSING 10,000 YARDS SUPERFICIAL OF DIFFERENT DESCRIPTIONS OF ROADWAY IN THE BOROUGH OF LIVERPOOL.

Street.	Description of Pavement.	When paved.	Condition of repair of Roadway.	Area of Carriage-way.	Loads removed in one Month.	Times swept in one Month.	Gross Cost per 10,000 Yards Superficial for each cleansing.
				Yds. supr.			£ s. d.
Lord Street	Granite setts, asphalte joints	1877	Very Good	4,503	15	26	0 6 5½
North John Street	Ditto	1872	Good	3,287	17½	26	0 8 10½
Tithebarn Street	Granite setts, ordinary joints	1872 and 1874	Bad	5,150	38	26	0 11 2
West Derby Road	Ditto, asphalte joints	1876	Very Good	11,980	35	13	0 9 4¾
Great Howard Street ..	Ditto	1877	Good	16,860	85	13	0 14 4½
Great Homer Street ..	Ditto, ordinary joints	Not ascertainable	Moderate	15,900	85	13	0 14 1
Kensington Street	Macadam breasted with setts	Ditto	Good	14,540	76	13	0 14 3¾
Stanley Road	Ditto	Ditto	Bad	16,534	186	13	1 8 9½

it may be mixed with the house refuse and sold to farmers, or the road scrapings themselves may be used as an excellent sand, if thoroughly washed, to mix with lime or cement to form mortar for public works; excessive accumulations of mud, however, must be got rid of in the most economical and speedy manner possible, and this is effected either by filling up old disused quarries with it, or depositing it upon waste lands, or forming embankments for new roads, but in no case should it be used, as I have before stated, upon building sites; it is difficult and expensive to destroy it or partially convert it into other matters by fire, so that if these methods which I have enumerated are impracticable, the only other method left for the disposal of the sweepings or scrapings from the streets is to take them out to sea in hopper barges and sink them in deep water.

The last question that arises on the subject of scavenging before we consider the disposal of snow, is whether the onus of cleansing private courts and alleys which are not repairable by the urban authority should be borne by them or not.

The great difficulty attached to this duty arises from the fact that these private courts and alleys are generally very badly paved, if paved at all, full of pits, where pools of stagnant mud and water collect, and even in the best cases, the interstices between the pebbles, or other paving, are filled with filth arising in great measure from the dirty habits of the people, and this filth it is found exceedingly difficult to dislodge. The remedy for this is to compel the owners of the abutting properties to have the courts and alleys properly paved with asphalte, or other equally impervious material; after which it would be easy for the urban authority to cause them to be swept at least once a day, and flushed with water in the hot weather once a week; but in order to compel the owners to execute this very desirable work it would be necessary to put the complicated machinery of section 150 of the Public Health Act 1875 in force, and the expense to the landlords would be

in many cases very disproportionate to the value of their property.

Out of the ninety towns to which reference has before been made, the authorities of only nineteen of them cleanse the private courts and alleys in their jurisdiction, although for the sake of sanitation it is very desirable that such work should be so undertaken by them.

In most towns it is necessary to cleanse its principal streets at least once a day, and this appears to be the practice of nearly all the ninety towns I have referred to; only seven of them, however, appear to have this operation repeated more frequently; in several towns, the horse droppings, &c., are removed at once, under what is called the "orderly" system, and this is especially necessary in streets that are paved with such materials as wood paving, asphalte, or granite setts. The suburban streets of a town need only be cleansed once or twice a week, except in special cases of extremes of mud or snow, and I will now proceed to discuss the questions involved by a heavy fall of the latter.

Experiments have shown that a cubic yard of fresh fallen snow may weigh as much as 814 pounds or as little as 71 pounds. Assuming that a cubic foot will weigh 16·38 pounds, I estimate that for a fall of 3 inches of snow upon a street 36 feet in width, 20 tons, representing a bulk of about 100 cubic yards, would have to be removed for every 100 yards of length of street if it was thought necessary to clear it away.

Assuming that there are 30 miles of street in a town from which the snow must be removed; 21,144 loads must be carted somewhere, at a cost of at least 1,500*l.*, assuming that each cart could make ten trips a day, and even then it would take 352 carts a whole week to effect it.

It may be contended that I have taken an extreme case, and that, of course, the snow does not lie for very long upon the ground in the condition in which it fell, and that hourly it is reducing in bulk and weight by being ground up by the traffic,

and finding its way in the form of water into the sewers. This may be so, but at the same time it must not be forgotten that the bulk is also being constantly increased by that which is shovelled off the house tops * and brought out from private premises adjoining the streets.

Upon this point Mr. Haywood, the Engineer to the Commissioners of Sewers of the City of London, says † :—

"Snow readily compresses under the traffic, and when removed in carts and shot down elsewhere it may be assumed that on an average four cubic yards of snow measured as it has fallen is equal to one cubic yard when placed on the apparatus." This computation, however, does not make any allowance for the snow thrown from off the roofs, &c., and it of course greatly consolidates whilst travelling in the cart.

Fortunately for a town surveyor in this country, exceptionally heavy falls of snow are not very frequent, but when they do happen great pressure is put upon his department to cope with it, and one of the greatest difficulties he has to contend against is the disposal of the snow after it has been placed in the cart.

If there is a river close by, it can be taken there and tipped ; but this is objectionable if it is a navigable river where dredging has to be done, as it is surprising what a quantity of road scrapings and other matters are always removed with the snow, and these materials naturally sink to the bottom, and add considerably to the cost of dredging.

If there are public parks the snow may be heaped in them, provided no damage is done to the grass or paths, but the snow thus heaped takes a considerable time to melt, the first effect of a thaw being to consolidate it: a better plan is to

* See note under "Other Obstructions and Nuisances," p. 155, 8th edition, Glenn's "Law of Public Health and Local Government."

† *Vide* "Report to the Streets Committee of the Honourable the Commissioners of Sewers of the City of London on Melting Snow by Clarke's Apparatus," by William Haywood, Engineer and Surveyor to the Commission, 1881, p. 9.

deposit it upon waste spots, if these are not too far from the streets which have to be cleared.

Tipping the snow down the manholes into the sewers has been tried in London and other cities, but has failed through the snow consolidating, and although lighted gas jets have been turned on to the snow, it has still melted too slowly to be of any practical utility.

Speaking of Clarke's apparatus for melting snow, Mr. Haywood, in the same report from which I have already quoted, says:

"It is seldom that a fall of snow occurs sufficiently large to cause serious interruption to the traffic; heavy snowstorms in fact occur only once in six or seven years; for some years therefore these apparatuses if fixed might not be required. They would either have to be taken out, stored and refixed yearly or maintained in their places and kept in order there; in either case at an annual expense."

In perusing Mr. Haywood's report it also appears that the cost of this apparatus fixed is about 120*l.*, and the cost of melting the snow 9*d.* per cubic yard.*

In order to grapple with this question of the removal of snow, I am of opinion that it is useless to attempt to cart it away while falling, but try to make clear crossings for the foot passengers and to keep the traffic open. If there should be a high wind at the time, and the snow drifts in consequence, cut through the drifts so as to allow the vehicular traffic to continue. Directly the snow ceases to fall, put on all available hands to clear the channel gutters and street gratings, in preparation for a sudden thaw, when, if these precautions were not taken, serious flooding and great damage to property might ensue; for the same reason cart away all the snow you can at the bottom of gradients and in the valleys, and also

* The application of direct heat to snow has so far failed, as under this process a liquid is produced which rapidly changes into ice. The expense also is very great, as the combustion of 1 lb. of coal will only melt about 18 lbs. weight of snow.

from very narrow streets and passages, &c. In the wider streets use the snow plough, or with gangs of men (in the snow season there is generally plenty of labour obtainable), shovel the snow into a long narrow heap on each side of the street, taking care to leave the channel gutters and gratings quite clear, and a sufficient space between the heaps for at least two lines of traffic. Passages must also be cut at frequent intervals through the heaps, in order to allow foot passengers to cross the street, and also to let the water reach the channel gutters as soon as the snow begins to melt.

The use of salt to assist in the removal of snow has made rapid progress during recent years, although it is contended by medical men and others, that the excessive cooling of the air and the danger to pedestrians who are not well shod is objectionable, and also that horses suffer therefrom, though this may be avoided by a plentiful application of grease to their hoofs and legs. In Liverpool the use of salt has been resorted to for some years without any apparent ill effects, and the following particulars of the manner in which this work is effected in Paris will no doubt be of interest.

The salt is spread so soon as any amount of snow commences to fall, as the mixture of salt and snow is then assisted by the traffic. At the end of four or five hours, when the snow is liquid, the roadway is machine swept and the footpaths cleaned with squeegees; water is then applied and the liquid mass is swept into the sewers.

The freezing mixture causes no damage whatever to streets paved with granite, wood, or asphalte, but it cannot be applied to macadamised roadways, as such streets become muddy, and the amount of detritus conveyed to the sewers would be excessive.

The amount of salt used is about $\frac{6}{10}$ of an ounce of salt for each square yard of surface $\frac{4}{10}$ of an inch deep. The salt should be in grains of from ·07 inch to 0·12 inch in diameter.

The next point to be considered in this chapter is that of

"The proper watering of streets for the whole or any part of their district."

One of the earliest methods for watering streets, but one which has entirely died out, on account principally of the large quantity of water used in the process, was that of allowing the water to run down the channel gutters, ponding it back by means of canvas or leather aprons placed across the gutter, and then spreading the water on to the surface of the street by throwing it with wooden shovels. This method, which at first sight may appear clumsy, is an exceedingly good one upon sanitary grounds. It not only lays the dust, but it washes the surface of the street, and it most effectually scours out the gutters and at the same time flushes the sewers, which at the season that watering is necessary is also of great importance to any town. By this process a delightful freshness is given to the air, and the appearance of the cool and limpid water rushing along on each side of the street acts favourably upon the inhabitants. The great objections to this system are (1) the enormous quantity of water that is used in the process, and (2) the difficulty of doing the work after the traffic of the day has commenced.

Somewhat of a modification of this process was that which was known as "Brown's System of Street Watering," which may be described as follows:—A lead pipe is laid in the footpath at the back of the kerb on each side of the street to be watered, small gratings or shields being fixed in the pipe at intervals of twelve inches, and the remaining space filled with asphalte; small holes are then bored in the pipe through the openings in the shields. The pipe is connected with the water main in the street, and is provided with the necessary stopcocks, etc. On the water being turned on, fine jets are thrown in different directions upon the surface of the street. The width of roadway that can be watered by this process depends upon the pressure of the water; but this process has not gained much favour hitherto, for many obvious reasons

which were quoted in the first edition of this book, but which I shall not repeat.

In Paris and other continental cities, and also in several towns in this country, the watering is effected by hose and reels, or by portable iron tubes.

Mr. Parry, C.E., the Borough Surveyor of Reading, has given the following particulars of the system of hand-watering adopted in that borough, in which he gives the cost, and describes the utility of that method as compared with the use of water-carts.

A water-cart (he states) will water twice a day a superficial area of 23,849 yards, and for a length watered one width that means 5,962 lineal yards, or for a double width 2,981 yards, the cost per day of laying on being as follows:—Horse, cart, and man 8*s.*, cost of maintenance of cart, harness, shoeing, &c., 1*s.* 5*d.*, making 9*s.* 5*d.* per day.

With respect to the hand machines he states that he has one of Headley's drum machines, and three of special make, somewhat similar to those used in Paris. They are equal in point of work; and one machine will water 23,740 square yards twice a day, which it will be observed, is very close to the amount of work performed by a cart.

"Headley's machine cost us (he continues), five years ago when new, 31*l.* 7*s.* 3*d.*, and the repairs and maintenance since that date have been 22*l.*, or an average of 4*l.* 8*s.* per annum, and it is just now almost past repair. The other description of hand machine cost each when new 20*l.*, and the repairs and maintenance have amounted to an average of 3*l.* 18*s.* each year. They were in use some time before Headley's was obtained, and they will be of use for a long time yet. The cost of labour per day by the hand machines is for two men at 2*s.* 10*d.* each—5*s.* 8*d.*—as it requires two men to work the machine properly, one to distribute the water, and the other to move the machine and to attach and detach the apparatus to and from the hydrants; add to this 7*d.* per day for maintenance and

it is cheaper to use this water than that from the ordinary town supply, provided that the capital expenditure upon the pumping station and mains, etc., is not excessive.

The advantages of sea-water for road sprinkling may be summarised as follows:

Owing to the deliquescent nature of the salts contained in sea-water the road remains moist for a much longer period than when sprinkled with fresh water.*

The result of this is that one sprinkling with sea-water will last as long as three sprinklings with fresh water. In consequence also of these salts a sort of skin or crust is formed on the surface of the road which tends to bind and preserve it, especially when it is macadamised with gravel. The air appears to be freshened by the use of sea-water upon the roads in the vicinity, and it has been proved over and over again that no damage arises therefrom to tradesmen's goods in adjoining shops. It has also been contended by the opponents to the use of sea-water that it assists decomposition of the organic matter lying on the surface of the roads; but this is only a contention, and with anything like proper scavenging should never even be suggested as possible.

No damage is done to horses' hoofs, tyres of wheels, carriage varnish, buried gas and water pipes, or even to adjoining trees if the watering is carried out in the ordinary manner, and the Author, who has had some considerable experience with regard to this question, gives his unqualified approval to the use of sea-water for sprinkling roads and for sewer flushing.†

* Sea-water contains 29 parts chloride of sodium (common salt) 0·5 chloride of potassium, 3·0 chloride of magnesium, 2·5 sulphate of magnesia, 1·5 sulphate of lime, or a total of 36·5 parts per 1000, or about 80 lbs. weight of solids in every water-cart containing 224 gallons of sea-water. (*Vide* "Street Watering with Sea-Water." A paper read before the Civil and Mechanical Engineers Society, 15 February, 1888, by Mr. Stephen Harding Terry, C.E., M.E., etc.)

† In Rouen, where chloride of calcium is obtained from the manufactories of pyroligneous acid in the neighbourhood, it is mixed with the water for use on the roads, and it is stated that on a mile of road, 16 feet in width, 5630 gallons of

Watering the roads with a largely diluted disinfectant such as "Sanitas" in the liquid form, is frequently of great benefit, and where it can be afforded, it should be occasionally done, especially in the narrower streets and more crowded districts of a city or town, or when an epidemic has broken out.

With reference to the very important question as to the cost of scavenging, street-cleansing and watering, it is, of course, not possible to lay down any hard and fast lines, as it must necessarily vary considerably according to circumstances; much depends upon whether the district is an urban one, consisting of houses closely packed together, or whether it is suburban, with scattered villas and mansions standing in their own grounds; the question, also, of the distance of the depôts to which the material has to be carted, considerably affects the result of any estimate, as also does the cost of horse hire, the rate of wages, and whether the district is of a hilly or flat nature, and, as I have before shown, the manner in which the streets are formed and paved, the habits of the people, the requirements as to cleansing streets and watering, and last, but not least, the manner of the eventual disposal of the rubbish after removal; all these points must bear with great weight upon any question of cost, and make the results widely different.

Before closing this chapter I will make a few observations upon the subject of contracts for work of this description.

There is no doubt that the "dust and slopping" contractor is fast going out of fashion, as it has been found that the work is far more carefully and systematically carried out without the intervention of a contractor; for if we turn to the articles of agreement or contract usually drawn up

water were necessary daily, but that the same result was attained with 1480 gallons of chloride solution, marking 30° Beaumé, and costing about ½*d.* per gallon, the humectation remaining good for five or six days with the solution of chloride. With water only in 1093 yards, in four rounds daily, 3520 gallons were used, the cost being 48*s.*: with chloride of calcium the cost was 32*s.* per day

CHAPTER XX.

SEWERAGE.

THE Public Health Act, 1875, contains a considerable number of clauses dealing with the subject of the sewers of a town, but two of the shortest sections of the whole Act, and yet those that involve a considerable amount of work in the town surveyor's department, are the following:—

"Every local authority shall keep in repair* all sewers belonging to them, and shall cause to be made such sewers as may be necessary for effectually draining their district for the purposes of this Act"† (38 & 39 Vic. c. 55, s. 15).

"Every local authority shall cause the sewers belonging to them to be constructed, covered, ventilated,‡, and kept so as not to be a nuisance or injurious to health, and to be properly cleansed and emptied"§ (38 & 39 Vic. c. 55, s. 19).

As to what sewers do "belong" to the local authority, the following section of the Public Health Act, 1875, states:—

* If the sewers vested in and belonging to a local authority are allowed by their negligence to get out of repair, they are liable to an action for damages. (*Vide* 'Fitzgerald's Public Health Act,' 3rd edition, p. 19.) Keeping in repair does not, however, include construction of entirely new works. (*Ibid.*)

† The sewers provided by a local authority must be sufficient to carry off the ordinary sewage and rainfall of the district, but they need not be sufficient to carry off an extraordinary flow of water caused by a storm; damage caused by that comes under the definition of damage caused by the act of God, for which there is no individual responsibility (*Ibid.* p. 20). This clause, however, seems to insist upon sewers carrying the rainfall.

‡ See chapter on "Ventilation of Sewers."

§ A local authority is not to be held liable for not keeping their sewers cleansed at all events and under all circumstances, but only where by the exercise of reasonable care and skill they can be kept cleansed. They are, however, liable, in case they make default in observing the requirements, to have an injunction filed against them and to be restrained by injunction from allowing the continuance of the nuisance. (*Ibid.* p. 23.)

"All existing and future sewers within the district of a local authority, together with all buildings, works, materials, and things belonging thereto,

"Except

"(1.) Sewers made by any person for his own profit, or by any company for the profit of the shareholders; and

"(2.) Sewers made and used for the purpose of draining, preserving, or improving land under any local or private Act of Parliament, or for the purpose of irrigating land; and

"(3.) Sewers under the authority of any commissioners of sewers appointed by the Crown, shall vest in and be under the control of such local authority.

"Provided that the sewers within the district of a local authority which have been, or which may hereafter be constructed by or transferred to some other local authority, or by or to a sewage board or other authority empowered under any Act of Parliament to construct sewers, shall (subject to any agreement to the contrary) vest in and be under the control of the authority who constructed the same, or to whom the same have been transferred" (38 & 39 Vic. c. 55, s. 13).

And as to the definition of the word "sewer," the same Act states:—

"'Sewer' includes sewers and drains of every description, except drains to which the word 'drain'* interpreted as aforesaid applies, and except drains vested in or under the control of any authority having the management of roads and not being a local authority under this Act."

The result of this acquisition by the local authority of the sewers in their district is, that in most of the old cities and towns a legacy of very defective and imperfect sewers has been inherited, and considerable expense in their repair and maintenance has thus been entailed.

A great number of books have been written on the

* For the legal definition of "drain," see the chapter on "House Drainage."

subject of sewerage, and much valuable information has been published from time to time, so that it almost seems superfluous to say much upon the subject; however, a few remarks which are particularly applicable to the work of a town surveyor may be of some service.

The word *sewerage* may be taken as meaning a system of sewers carrying *sewage*, which is the fluid and feculent refuse from dwellings and their yards, &c. Sewage is generally found mixed with rain water from the surface of the streets and roofs of houses, together with the liquid waste products from manufactories,* and sometimes, although very improperly, with subsoil water.

A good system of sewerage should embrace the whole of the following requirements:—

(1.) Each sewer should be laid at such a depth as will readily drain the basements of the adjoining buildings.

(2.) Its area and gradient must be so regulated as to make it self-cleansing, and at the same time carry off

* Facilities must be given to enable manufacturers to send the liquids proceeding from their works into the public sewers, provided the sewers are more than sufficient for the requirements of the district, or if the liquids would not prejudicially affect the sewers, or from their temperature or otherwise be injurious in a sanitary point of view. *Vide* Rivers Pollution Act 1876 (39 & 40 Vic. c. 75, s. 7). This permission, however, led to so much litigation, that the Public Health Acts Amendment Act 1890, has the following clauses thereon, which are contained in Part III. of the Act, which can be adopted by any urban authority.

"16.—(1.) It shall not be lawful for any person to throw, or suffer to be thrown, or to pass into any sewer of a local authority or any drain communicating therewith, any matter or substance by which the free flow of the sewage or surface or storm water may be interfered with, or by which any such sewer or drain may be injured.

(2.) Every person offending against this enactment shall be liable to a penalty not exceeding ten pounds, and to a daily penalty not exceeding twenty shillings.

"17.—(1.) Every person who turns or permits to enter into any sewer of a local authority or any drain communicating therewith—

(*a.*) Any chemical refuse, or

(*b.*) Any waste steam, condensing water, heated water, or other liquid (such water or other liquid being of a highter temperature than one hundred and ten degrees of Fahrenheit),

which, either alone or in combination with the sewage, causes a nuisance or is dangerous or injurious to health, shall be liable to a penalty not exceeding ten pounds, and to a daily penalty not exceeding five pounds."

effectively the maximum quantity of liquid for which it is intended.*

(3.) Each sewer should (unless quite impracticable) be laid in straight lines and with even gradients between man or lamp-holes, and these gradients must not be excessive, or damage may be caused to the sewer.

(4.) Sewers must be laid at proper levels in respect of their intersection with each other, bearing in mind that they are all generally converging to one point.

(5.) Manholes should be of simple construction; circular brickwork upon concrete is a convenient description. They may be made to serve the additional purposes of ventilating shafts, flushing chambers, junction shafts, storm overflows, and side entrances.

(6.) Tributary sewers and drains should not join the main sewers at right angles unless the bottom of the manhole is so constructed as to give the required curve in the direction of the flow of the sewage, and they should join at a height (if of unequal section) equal to the difference of their sectional diameters, the aim of all junctions being to cause as little disturbance as possible in the proper flow of the liquids along their respective channels.

(7.) Sewers should not be constructed of too large a sectional area, but none should be less than 6 inches internal diameter, as house-drains in this country are never less than 4 inches diameter, and the main sewer should, of course, be larger than its tributaries. It is also rather difficult to ventilate a smaller sewer than 6 inches, and very little is saved by putting in a smaller sewer than that.

* If everything has to be carried in a sewer, the following provisions must be made:—

(*a.*) The house sewage, which may be calculated from the water supply.

(*b.*) Manufacturer's refuse.

(*c.*) Rainfall, which is a very uncertain quantity.

(*d.*) The subsoil water should certainly be dealt with, but it should on no account be permitted to enter the sewers themselves; separate provision under the main sewers should be provided for this purpose.

Stoneware pipes of greater diameter than 18 inches should never be used. Where larger sewers are constructed they should be either concrete pipes, or brickwork or concrete should be employed.

The position of the sewer should, if possible, be behind the houses for the following reasons:—

(1.) The water-closets, sinks, &c., being nearly always at the back, a drain under the house (which is always objectionable) is avoided.

(2.) Economy is secured to the owner of the property, as a shorter length of drain is required than if the sewer was in the front.

(3.) A better fall is usually obtained.

(4.) Where there is a separate or partially separate system of sewerage, a double sewer in the street is avoided.

The only objection to this method being that of the chance of the sewer becoming choked or broken, when entry has to be made into private property to repair it; but this ought never to happen after once the sewer has been properly constructed, and in many towns in order to avoid this a back street is constructed behind the houses, which has many advantages. Of course, where houses are closely packed together it would not be possible to carry the sewer at the back; but where it can be done I agree thoroughly with Sir Robert Rawlinson, C.B., who, speaking of this method, says, "I know nothing but good of it."

Where the sewer is proposed to be taken through any private lands it is necessary to act in accordance with the following clause of the Public Health Act, 1875, and serve the necessary notices, a specimen form of which also follows:—

"Any local authority may carry any sewer through, across, or under any turnpike road, or any street or place laid out as, or intended for a street, or under any cellar or vault which may be under the pavement or carriage-way of

any street, and, after giving reasonable notice in writing to the owner or occupier (if on the report of the surveyor it appears necessary), into, through, or under any lands* whatsoever within their district. They may also (subject to the provisions of this Act relating to sewage works without the district of the local authority) exercise all or any of the powers given by this section without their district for the purposes of outfall or distribution of sewage" (38 & 39 Vic. c. 55, s. 16).

The form of notice necessary to be served before entry upon any lands for the purpose of carrying out any sewerage works may be on the following pattern:—

"NOTICE IS HEREBY GIVEN.

"1. That the mayor, aldermen, and burgesses of the borough of , in execution of the powers and authorities given to and vested in them by virtue of the Public Health Act 1875, upon the report of their surveyor, whereby it appears to the said authority to be necessary to enter into, through, or under the lands and premises particularly described in the schedule hereunder written, for the several purposes hereinafter mentioned, the said mayor, aldermen, and burgesses will immediately after the day of enter into and upon the premises described in the said schedule hereto, and on the plan hereinafter mentioned numbered , for the purpose of in, through, or under the said lands and premises , and to construct all other necessary works for all or any of the purposes aforesaid.

"2. The course of the said sewer is indicated by a line drawn on the said plan from the point to .

* The definition of "lands" as given in the Public Health Act 1875, is as follows:—"'lands' and 'premises' include messuages, buildings, lands, easements, and hereditaments of any tenure' (38 & 39 Vic. c. 55, s. 4).

"And notice is hereby further given that a plan of the intended works, and of the lands and premises upon which it is intended to enter for the construction of the same, is now open for inspection, between the hours of 10 in the forenoon and 4 in the afternoon, and may then be seen at the offices of the borough surveyor, Street, , and a tracing thereof is hereunto annexed.

Dated this day of 18 .

Town Clerk."*

In carrying out works of sewerage the greatest care is necessary in the materials selected and the manner in which the work is executed. Tunnels and shafts must be most carefully timbered, levels very accurately given and adhered to, and for this purpose sight rails and long boning rods can be used with great advantage. In running sands, or where the line of an old sewer is being followed, or in fact anywhere where a good and quick joint is required, "Hassall's" patent safety jointed pipes can be used with advantage.

The joints of these pipes may be described as follows: two bands of special bituminous material are cast on to the spigot end of the pipe about 1½ inches apart, and corresponding rings of the same tough mixture are cast inside the pipe socket also about 1½ inches apart. These two sets of rings when the pipes are together form an annular space round the whole joint of the pipe which is filled, through a hole provided for the purpose, with liquid cement which travels completely round the pipe driving before it any air, water, grit, or dirt that is in the space. This also tests the joint, for should there be any leakage it will appear during this operation. When the cement has set it will be seen on

* Notices may be signed either by the clerk to the local authority or their surveyor (38 & 39 Vic. c. 55, s. 266).

reference to the section given on page 299 that this joint hermetically closes the pipes and prevents the possibility of any leakage, and from its double bearing lessens considerably the chances of any settlement. Hassall's pipe is, in my opinion, the best that is at present known to engineers and surveyors.

Breakages sometimes occur in stoneware pipe sewers after they are laid, which generally are found on examination to arise from one of the following causes:

(1.) Laying the pipe on a rigid foundation without recessing the sockets so as to give an even bearing.

(2.) Laying the pipes on foundations which afterwards yield or settle.

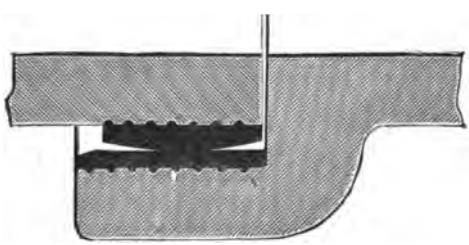
(3.) Laying the pipes at too great a depth without protection by concrete or otherwise to resist the pressure of the superincumbent earth, or by not sufficiently punning the filling-in, when a sudden settlement will often crack or crush a pipe.

(4.) Accidental or wilful injuries to pipes which are not noticed before the trench is filled in.

(5.) Laying the pipes at too shallow a depth without protection, when heavy traffic or a falling weight upon the surface will crush or crack a pipe.

(6.) Defective or weak pipes.

The following plates give some of the different forms of sewerage pipes which have from time to time been brought to the notice of town surveyors.

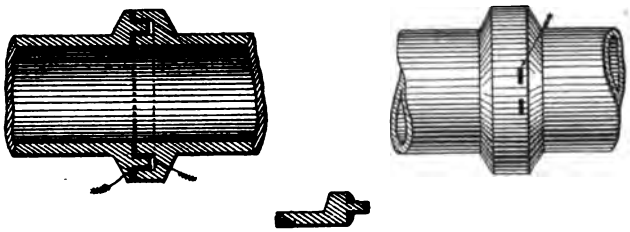


DOULTON'S PATENT SELF-ADJUSTING JOINT FOR DRAIN PIPES.

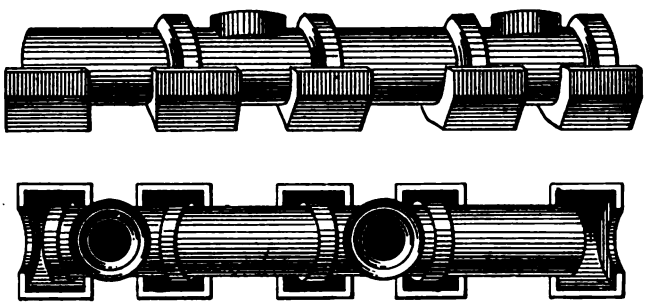
The chokage in pipe sewers generally arises from one or more of the following causes :—

(1.) Improper gradients.

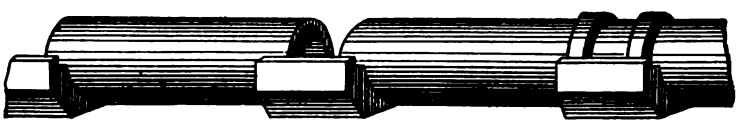
(2.) Insufficient flush.*



ARCHER'S PATENT AIR AND WATER-TIGHT PIPE.



MAGUIRE'S PATENT SAFETY JOINT DRAIN.



JENNINGS' PATENT CHAIR AND SADDLE PIPE.

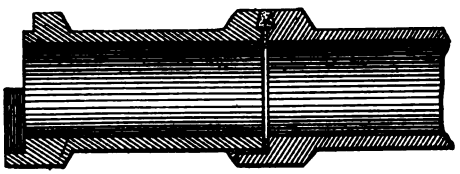
(3.) Foreign articles finding their way into and choking the sewer.

(4.) Defective joints through which the liquid runs leaving solid matters behind.

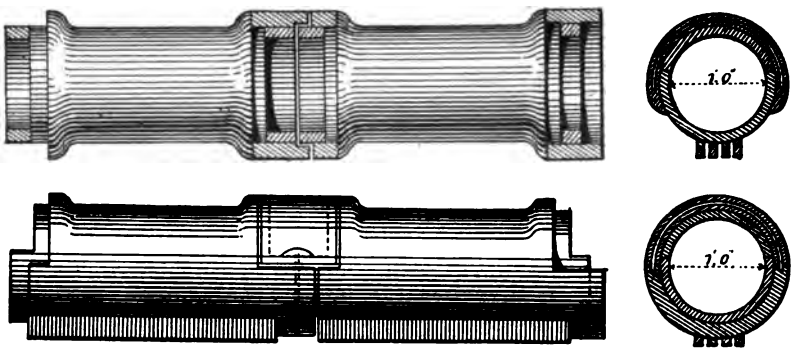
* The patent automatic flushing arrangements by Mr. Rogers Field, and others, are excellent for lessening the chances of a sewer becoming choked from this cause.

(5.) An excess of road detritus or of ashes, through the house closets of the poor, finding their way into the sewer.

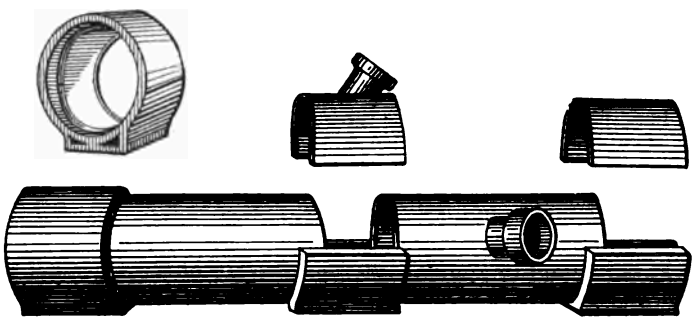
(6.) Improper bends in the line of sewer.



MAWBEY'S PATENT GROOVED SOCKET PIPE.



BOULNOIS AND HILDER'S ACME PIPE.

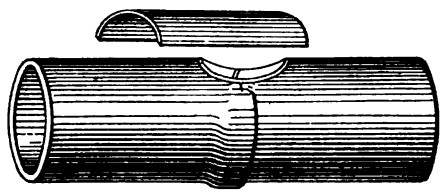


STIFFS' IMPROVED REGISTERED DRAIN PIPE.

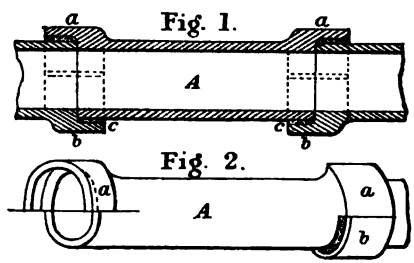
(7.) Right-angle or improper junctions being formed with the sewer.

(8.) A collapse of the sewer.

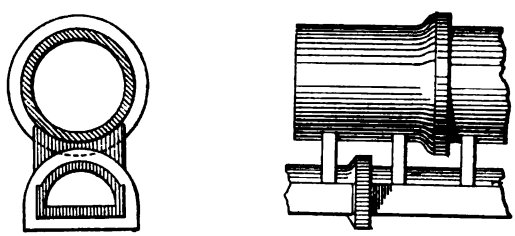
A temporary chokage in a small-sized sewer which does not arise from any structural defect can be speedily and effectually remedied by the use of drain-cleaning rods, which are probably too well known to every town surveyor to need any description, but in conjunction with man- or lamp-holes and straight lines of sewers they are very valuable.



CREEKE'S PATENT CAPPED PIPES.



NOOT'S HALF-ROCKETED PIPE JOINT.



BROOKE'S PATENT SUBSOIL DRAIN AND PIPE REST.

Before closing this chapter, a few words upon what is called the "separate system of sewerage" may be of use.

A mistake was originally made in trying to absolutely separate all rainfall from the sewers, but it is now found that a partial separation of the rainwater from the sewage proper

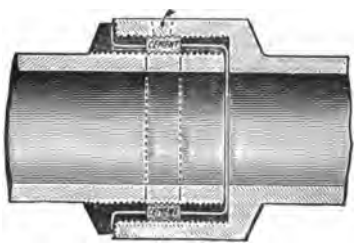
has many advantages; in carrying this out, however, it is found impossible to exclude the rain-water that falls upon the roofs of buildings and on back yards and small back streets, and allowance must always be made for this amount of surface water in all calculations for the "separate" system. A partial separation thus carried out has the following advantages:

(1.) It is not necessary to have sewers of enormous diameter.

(2.) The depth of the surface water conduits need not be so great as that which is necessary for sewers.

(3.) The exclusion of road detritus from the foul sewers.

(4.) Its evident advantages where the sewage has to be pumped, or treated chemically, or put on the land.*



HASSALL'S PATENT SAFETY PIPE JOINT.

(5.) The greater accuracy with which the quantity of sewage may be calculated and the sizes of sewers apportioned.

(6.) Economy both to the general rates and also to individuals in carrying out their connections.

(7.) Where old and defective sewers exist they may be used to carry surface water, although quite inappropriate as sewage carriers.

No rules, however, can be laid down with regard to this question, as each town or district must be treated as the case requires.

* It is necessary in many towns where the combined system is in force, and the sewage has to be pumped when heavy rains commence, to put temporary clay dams round the street gratings to prevent the surface water from entering the sewers, thus at once showing the inability of the system to deal with flood waters.

In conclusion, I will mention the different methods at present in vogue for the sewerage of towns.

(1.) The combined system, where all sewage, surface water, manufacturer's refuse, and subsoil waters are carried in the same sewer.

(2.) Similar to the above, the subsoil water, however, being carefully excluded.

(3.) The partially separate system.

(4.) The dry systems, which consist of—

(*a.*) Earth closets;

(*b.*) Tubs, as the Goux, &c.;

(*c.*) Pails, as the Rochdale;

(*d.*) Middens.

But all these dry systems require some system of sewers to carry off rain-water, slop-water, &c., and in my opinion are not suitable for very large communities.

Before closing this chapter it will be well to draw attention to "Shone's" pneumatic ejector system, which is described as follows:—

"The ejectors are cast-iron receivers of a suitable form, placed underground at depths to suit the locality, into which ejectors the sewage flows through the ordinary pipe drains from the houses. As the liquid rises in the interior of the ejector, and when full, it lifts a valve and admits compressed air from an engine which supplies the entire district. The ejectors are thus emptied of their contents, which are blown out in about eighty seconds of time, and the sewage passes through cast-iron main pipes of suitable diameters to the land, or other outlet provided to receive it, or it may be distributed upon the waste land as it passes through."

Many of my readers are acquainted with this admirable and ingenious invention, which under certain conditions can be most advantageously applied in connection with "sewerage."

CHAPTER XXI.

SEWAGE DISPOSAL.

THE magnitude of the question of "sewage disposal" almost decided me to refrain from making any remarks upon it, but on reconsideration I thought a few might be serviceable.

Sewage disposal means the getting rid of the foul water contained in the sewerage system of any community.

Where a dry method is in force for the collection of the excrementitious matters it is called "interception"; the following are some of the systems which effect it:—

Privies, ashpits, middens cesspools, pails, troughs, the "Rochdale," the "Eureka," the "Goux," Fosses Permanentes, Fosses Mobiles, and Moule's, Taylor's, and Phillips' earth closets.

In consequence of the growth of cities and towns, the collection and disposal of the mass of excrement under these dry systems is found to be a very troublesome matter, and they are at their best but inferior substitutes for water carriage, nor must it be forgotten that sewers and drains are necessary even if a good interception process is in force. I shall therefore confine my remarks to the disposal of water-carried sewage.

Many books have been written, many valuable reports have been prepared and issued, lengthy papers and discussions have been frequent at the meetings of scientific societies, and almost innumerable pamphlets have been published upon this important sanitary subject. Some millions of money have also been spent in trying to deal satisfactorily with this ques-

tion, not only with a view to the purification of the effluent of the sewage, but also to endeavour to make a profit out of the residuals.* The result of this literature, discussion, and experiment has led to the following conclusions :—

No hard and fast lines can be laid down as to the best method to be adopted for the disposal of the sewage of any town, but the peculiar circumstances of each case must be considered before advice could be given on the subject: geographical position, physical arrangement, water-supply, habits of the population, and the character and quantity of the sewage of the town being some of the most important.

In any case it is necessary that the transmission of the sewage to the outfall should be effected as speedily as possible, and that the position of this outfall should be such as to cause no nuisance. The contents of the sewers should, if possible, be emptied by gravitation, as pumping is a constant expense, and economy with efficiency must of course be studied.

Up to the present time the following are the methods adopted in this country for the disposal of sewage :—

(1.) Passing the sewage in its crude state into the sea or tidal river.

(2.) Passing the sewage in its crude state over large tracts of land ; this is called broad irrigation.

(3.) Passing the sewage in its crude state on to small tracts of land previously prepared by deep drainage ; this is called intermittent downward filtration.

(4.) Mechanical subsidence of the sewage in large tanks, the effluent passing on to land or into a river.

(5.) Mechanical filtration of the sewage, the effluent passing on to land or into a river.

(6.) The introduction of lime or other precipitant into the sewage, which is allowed to settle in tanks, the effluent passing on to land or into a river.

* It has been computed that every ton of liquid sewage which is treated chemically costs about three-quarters of a farthing.

(7.) The combination of filtration with precipitation, the effluent passing on to land or into a river (Ferozone Process).

(8.) Treatment by electrolysis, or the application of electricity (Webster Process).

Very little need be said upon the first of these methods. Many engineers of high standing contend that, where practicable, the sea or the tidal estuary of a river is the right place for the sewage, as no costly works are necessary, and an abominable nuisance is thus got rid of at once and for ever. To ensure this, however, great care must be exercised in the selection of the site for the outfall. Float observations should be made, not only of the surface tides and currents, but also of those at different depths, and the effect upon the sewage by its different specific gravity from that of the salt water must be allowed for, as well as the difference of level of the tides and the configuration of the adjoining coast line.

The second method, that of broad irrigation, is one that finds considerable favour with a large number of engineers and agriculturists. The great sewage-disposal cry has always been, "Put back on the land what you have taken from it, or some day there will be no beef and no bread." The difficulty is to always find land in sufficient quantity and so situated as to be available for this purpose. Almost any soil is, however, suitable for irrigation, provided it is well and properly drained. The quantity of sewage which should be used for this purpose per acre of land varies considerably, as will be seen on reference to a table prepared by Mr. Henry Robinson,* where the number of inhabitants to each acre irrigated is, in one case (Leamington), stated to be 55, in another (Blackburn), 208,† the average being 137, the number of gallons per head of population per diem being 38.

It may be useful to state here that a hundred tons of sewage will cover an acre of land 1 inch in depth, and that the

* *Vide* "Sewage Disposal," by Henry Robinson, C.E., 2nd edition, p.79.

† I purposely omit (Kendal) 856, as this is properly speaking, "filtration."

value of sewage as a manure is said to vary from ½*d.* to 2*d.* per ton, or, calculated in another manner, about 10*d.* per head of population per annum.

The best crops for a sewage farm (in addition to nearly all kinds of market-garden produce and osiers) are rye-grass, mangolds, beetroot, cabbages, carrots, potatoes, turnips, rabi, parsnips, lucerne, beans, wheat, oats, and barley; the cereals, however, are apt to run rather to straw, and some care is also necessary not to over-sewage potatoes and some other root crops. Grazing cattle or cows can also be carried on with advantage, the presence of sewage having apparently no effect either on the milk or flesh of animals fed on sewage farms.

The third method, that of intermittent downward filtration, is really irrigation of land to such an extent as the land will filter or purify the sewage, the effluent passing off pure, irrespective of any effect upon the crops which may be growing upon the land.

Great discussions have arisen (the principal battle-ground being Merthyr Tydvil) as to the maximum quantity of sewage which an acre of properly prepared land will treat; some of the champions of this system contending that a good porous soil properly drained to a depth of six feet will purify the sewage of 6000 persons per acre, others that only the sewage of 250 persons can be so treated.*

There can be no doubt that earth has a most powerful deodorising power. Laboratory experiments have shown that as much as eight gallons of sewage can be filtered through a cubic yard of loamy soil in twenty-four hours, the soil being drained at a depth of six feet, the effluent therefrom having obtained a wonderful degree of purity. Much, however, must

* For much interesting information upon this and other subjects in connection with sewage disposal, see 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. xlviii. p. 105 et seq. Also the report of a committee of the Local Government Board on Modes of Treating Town Sewage, 1876. "Sewage Disposal," by Henry Robinson, C.E., "Sewage Disposal Works," by W. Santo Crimp, C.E., and many other books and pamphlets upon the subject.

depend upon the character of the soil of the filtering area, and the strength of the sewage which is being operated upon. Nitrification, to which the purification of sewage is largely due, is the result of an organised ferment which occurs in soils and impure waters. This action is greatly interfered with by the presence of antiseptics, and consequently the refuse of chemical works in sewage may thus sometimes prove a considerable hindrance to the purification of sewage by soil.

Land when used as a sewage filter requires constant aëration by being dug over or ploughed, and if this precaution is taken, it is surprising to what a wonderful extent the land will take sewage without becoming what is called "sewage sick."

Clay soils should not be deep drained, but it assists them greatly to top-dress with about 4 inches of screened ashes from home refuse, which is then ploughed into the soil.

The next method, that of mechanical subsidence of the sewage in large tanks, has been attempted in conjunction with irrigation and filtration without much benefit, nor has the fifth method I have mentioned, viz., that of mechanical filtration of the sewage, met with any better result. Artificial filters have been constructed of burnt clay, cinders, coke, charcoal, peat, chalk, gravel, broken stone, sand, spongy iron (this is now being applied very successfully for the purification of water), straw, cocoa-nut matting, wicker-work, and wire gauze of different degrees of fineness of mesh. The late Mr. Odams spent a considerable sum in endeavouring to strain sewage through revolving screens of wire gauze with but little success, and Mr. Banner has striven to achieve the same object by passing sewage over oscillating screens of like material.

In all these cases of mechanical filtration, however, the effluent has either not been sufficiently pure, or the screens and filters have become clogged and refused to act.*

* Under the Rivers Pollution Act, no effluent is allowed to enter a stream, &c., if it contains more than three parts of suspended inorganic matter, and one part organic matter for every 100,000 parts of liquid.

The sixth method, that of precipitation, means the production, by the introduction of chemical substances within the body of the sewage, of certain solid compounds, which, in settling, drag down with them the suspended matters in the sewage, together with a small proportion of the polluting matters which are in solution in the sewage, this proportion varying with the quantity of solid matters deposited. The effluent from the tanks in which this precipitation takes place is then allowed to flow direct into a river or stream, or is still further purified by being passed over land or filtered through deep-drained soils.*

Chemical treatment of sewage was first tried in Paris in the year 1740, and since then every effort has been made to extract a valuable and commercial manure from sewage and purify the effluent. Between the years 1865 and 1875 more than 400 patents were taken out in respect of these and other matters in connection with the sewage question.

It is almost needless to say that but few of these patents were of any practical value. Those processes which have some merit and are now best known are, I believe, included in the following list:—

LIST OF CHEMICAL PROCESSES FOR THE TREATMENT OF TOWN SEWAGE.

The A. B. C. (or Sillar's) process
The Amines process
Anderson's ,,
Anson's ,,
Bird's ,,
Blyth's ,,
Campbell's ,,
Candy's ,,
Collins' ,,
Farmer's ,,
Forbes and Price's process
Fulda's process
Goodall's ,,
Hanson's ,,
Higg's process
Hille's ,,
Holden's ,,
Lenk's ,,
Lundy's ,,
Manning's ,,
Scott's ,,
Smith's ,,
Spence's ,,
Stothert's ,,
Suvern's ,,
Whitthread's process
Wickstead's ,,

* Experience has shown that up to the present time no chemical precipitation process renders the sewage effluent sufficiently free from decomposing matter as to

Space will not permit me to describe these processes, and probably most of them, if not all, are familiar to my readers. Suffice it to say that in nearly all cases the *modus operandi* is that of mixing certain chemicals with the sewage by mechanical agitation, or by passing the sewage over "salmon ladders," &c., then allowing the sewage to remain perfectly still whilst the solids are gravitating, and then dealing with the effluent in different manners.

Amongst the numerous chemical ingredients which are used for this purpose may be mentioned the following:—

Alum, animal charcoal, ashes, blood, bone ash, black ash, carbolic acid, chalk, charcoal, chloride of lime, chloride of zinc, chloride of iron, chlorine, clay, creosote, hæmatite, lime in a variety of forms, lead nitrate, magnesian salts, oxide of manganese, permanganate of soda, perchloride of iron, salt, soda, sulphate of alumina, sulphate of zinc, sulphate of iron, sulphuric acid, and tar.

The seventh process I have enumerated, that of the combination of filtration with precipitation, it is asserted, has been successfully brought into operation at Acton by what is known as the Ferozone and Polarite process. This is effected by treating the sewage with Ferozone which contains a large proportion of ferrous iron salts, salts of alumina and magnesia, finely divided porous magnetic oxide of iron, and finely powdered polarite, which in its turn contains magnetic oxide of iron, alumina, magnesia, silica, and lime. After deodorisation and precipitation in tanks, the effluent is made to pass through two small filters composed as follows: coarse gravel intersected with drain pipes is laid upon the floor of the filter, then four inches of pea gravel, then six inches of sand, then ten inches of polarite mixed with sand, and on the top nine

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make it safe to allow it to enter a river or stream direct without the intervention of the nitrifying and oxidising effects of passing it through soil. If this is not done, what is called secondary putrefaction sets in, and the river or stream is polluted thereby.

inches of sand, the effluent from the precipitating tanks passes downwards on the intermittent principle.

No details of the cost of this process have yet been published, but it is stated on good authority that although the Works have been in operation for about two years the only cleansing of the filter bed which has been found necessary has been the removal from time to time of the surface layer of sand, and that the effluent has never exhibited any putrefactive change, but has, if anything, undergone improvement.

The last method that I have mentioned for the disposal of sewage is that of its treatment by electrolysis, or the application to it of electricity.

Mr. Webster, F.C.S., the inventor of this process, says: "The oxidation of organic matter can only be attained by one mode of chemical action, whether it be by filtration accompanied by the action of micro-organisms, the addition of chemicals or by mechanical force represented by the electric current."

It would be impossible in my available space to give any description of the manner in which Mr. Webster applies his electric current to the sewage; but it is claimed for it that this current "produces a precipitating and oxidising action similar to natural processes in which the organic matter is destroyed by oxidation due to dissolved oxygen slowly absorbed from the air, assisted in many cases by matters in the soil, such as oxides of iron acting as carriers of oxygen." ("Sewage Disposal Works," by W. Santo Crimp, C.E., page 268,) to which book I confidently refer my readers for most valuable information upon the subject of this chapter.

One of the great difficulties in connection with the precipitation of sewage is the disposal of the sludge which is left behind in the tanks.

This sludge contains about 90 per cent. of moisture, and if left to dry atmospherically, a thin crust forms over it, thus

protecting that which is underneath, and it will not dry for many months. In some cases it is sought to dispose of the accumulations of sludge by digging it into the land, and in others by barging it away to sea in a semi-fluid condition. Sometimes it is mixed with house ashes, &c., and sold as manure; its bulk, however, in proportion to its manurial value is so excessive as to render it almost valueless, and it is difficult to get rid of it for this purpose even when fortified with ammonia or other chemical. Another practice was to reduce its bulk by exposure or by presses to a semi-dried condition; in other cases it is dried to a powder by heat, and the late General Scott patented a method where, in connection with the lime process, it was to be burned and manufactured into cement. The great difficulties in connection with this matter have to a great extent been now met by the introduction of mechanical processes, such as Pedder's, Needham and Kite's, Johnson's, Drake and Muirhead's, or Manlove, Alliot and Fryer's.*

For drying the sludge by heat, Borwick's or Forrest's machines have been used with some success, but there is no doubt that the slimy, glutinous, albuminous, offensive mixture technically known as sludge is a difficult matter to dispose of in all sewage works.

* It is stated that the sludge thus dried and pressed is worth twelve shillings a ton, but at present there does not seem to be a great demand for it by farmers.

CHAPTER XXII.

SEWER VENTILATION.

THE Public Health Act 1875 contains the following clause:

"Every local authority shall cause the sewers belonging to them to be constructed, covered, ventilated and kept, so as not to be a nuisance, or injurious to health, and to be properly cleansed and emptied" (38 & 39 Vic. c. 55, s. 19).*

The result of this compulsion upon Local Authorities to ventilate their sewers has been the introduction of many methods in order to endeavour to effect the purpose, the great difficulty being to ventilate "so as not to be a nuisance or injurious to health."

The advocates of open ventilation contended for many years that this was completely and expeditiously effected by making a sufficient number (about every 50 to 100 yards) of openings in the crown of the sewer, thus as to dilute and safely disseminate the foul gases with the atmosphere, and that when this was done no nuisance was caused. If however there is any truth in the germ theory of disease, this practice seems fraught with danger to the unsuspecting passer-by, and certainly does not comply with the provisions of the above section of the Public Health Act; consequently, of late years

* "Local Authorities should remember that not only do the Acts under which they are constituted give them no power to create a nuisance to others, but they are expressly prohibited from causing any such nuisance by the manner in which their sewers are made and maintained." *Vide* 'The Law of Public Health,' Glenn, 10th edition, p. 42.

many engineers and sanitarians have agreed that this practice is by no means perfection, but that it must suffice until a better method has been introduced. *

It is unnecessary to repeat the objections to this method of sewer ventilation which were enumerated in the first edition of this book, and it will be evident from the list of other methods which follow, that the open system of ventilation commenced in the year 1830 is not considered to be a solution of the problem.

Between the years 1848 and 1853 amongst other suggestions was one to construct high cast-iron cylinders over the sewers in which furnaces should be placed to consume the gases; another to build domes over the sewers from which pipes should conduct the foul air to central gas-holders, whence after purification it should be distributed for street lighting! Further suggestions were made with a view to pump the foul air out and disinfect it, and another that coke factories should be established along the lines of sewers and the foul air passed through the ovens.

In 1854 the late Sir Joseph Bazalgette successfully ventilated a sewer by carrying pipes from its crown into some factory chimneys; an explosion which afterwards occurred in connection with this arrangement led to the abandonment of experiments in this direction for a considerable period.

About this date the effect of passing steam jets into sewers was tried; but it is scarcely necessary to say the result was not satisfactory.

In 1855 ventilation through the hollow columns of the street lamp-posts was first put into operation.

In 1856 shafts were erected at the ends of streets connected with the dead ends of sewers, and carried up the

* Speaking of this system of so-called ventilation of sewers at a Congress of the Sanitary Institute in 1882, Mr. Geo. Laws, C.E., said, "as a means for securing that every person passing by shall breathe the greatest possible amount of poisonous gas this arrangement is almost perfect; but as an outcome of engineering effort it is depressing."

gable ends of houses, a practice which has more recently been beneficially extended.

In 1858 Mr. John Chisholm tried the effect of electrical or galvanic action upon the air in sewers, but without any good results.

In 1866 charcoal trays were introduced, a description of which or the reasons for their failure, it is unnecessary to give.

In 1870 trays filled with sulphurous acids were introduced into sewers with very fair results, but the system was troublesome and expensive.

In 1872 and 1873 screens or flaps were first introduced into sewers, and attempts were made to sectionise the ventilation and regulate the currents of air. About this date a suggestion was made that ventilation should be effected by connecting all the house drains with the kitchen chimney flues; a suggestion which called forth another: that the smoke from all chimneys should be diverted into the sewers so as to purify the bad air in them, and at the same time settle the London fog question satisfactorily!

In 1875 Mr. Parker patented a method by which air was to be forced into a sewer by the action of the wind impinging upon a cowl; and Mr. Rumbold originated a method for passing the foul air through a spray of water introduced on all sides of the ventilating shaft.

In the same year, having myself noticed the absence of smell in an old sewer in which stagnant sewage was giving off gases of decomposition, I came to the conclusion that this absence of smell arose from defects in the crown of the sewer which allowed the gases to be absorbed into the soil above. The outcome of this observation was the introduction of my system of sewer gas annihilation, based upon the well-known fact that earth acts as an absorbent and deodoriser of gases and emanations from decomposing matters.*

* In the year 1880 having patented my apparatus and satisfied myself of the efficacy of my system, I read a paper on the subject at a Congress of the Sanitary

In the year 1882 Mr. Read, the surveyor of Gloucester, suggested that all house drains should be used as upcast shafts; his argument being that as the sewer was used for the benefit of house property they should contribute to the ventilation. In the same year the late Mr. Harrington patented a system analogous to that introduced by Mr. Parker in 1875, and already described. In the year 1883 Mr. Rowan, and also Mr. Banner, introduced specially constructed exhaust cowls for the purpose of abstracting the foul gases from the sewers; but experiments have since proved that open terminations to the upcast shafts are as effective as exhaust cowls for this purpose.

About this date Messrs. Midgley, Reeves & Co., proposed a system by which chemicals should be introduced into the sewers at the manholes, and at the same time disinfect the

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Institute held in Exeter; and after the paper had been read, the President of the Congress, a leading Sanitary Engineer, said, "he could not encourage Mr. Boulnois to continue his experiment. He would not himself adopt it and could not advise others to do so. . . . He could not regard Mr. Boulnois' plan with the slightest degree of satisfaction. If we stopped the ventilation of a sewer we should soon have the whole population down with typhoid." *Vide* 'Transactions of the Sanitary Institute of Great Britain,' vol. ii. p. 166. In the face of such words as these from one who was in a position to make or mar any sanitary scheme, I felt that it was hopeless to proceed any further with the system and I consequently allowed the matter to drop. My readers may therefore judge of my surprise when ten years later I read the following remarks, which were made by the same eminent authority at a District meeting of the Association of Municipal and County Engineers at Wimbledon. "If I had a town to sewer now and I had to use brick sewers or pipe sewers I would take care to put ventilators in the crown of my sewer—not the entire length probably, but we will say for ten or fifteen feet in length at intervals of sixty or seventy feet apart—perforating portions of the top of the sewer with small honeycomb perforations, over which I would lay gravel and let any foul air that might arise in the crown disperse itself in the sub-soil. I am perfectly certain that no injurious emanations could arise under the street that could do any injury, and it would tend to sweeten the sewer. *I think a gentleman at Portsmouth has taken out a patent for something of a similar kind, that is, to carry a drain pipe through the crown of the sewer connecting the pipe with a horizontal pipe along the top of his sewer.*" *Vide* 'Minutes of Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. xvi. page 27. The italics are mine, as I was Borough Engineer of Portsmouth, and the patent not quite correctly described was mine.

connected with the sewer by ordinary 6-inch socket drain pipes. The destructor is placed in the base of the column, and consists of an atmospheric gas burner. The gas is admitted from below, and just at the point where the gaspipe joins the tube of the burner is inserted an ordinary No. 6 Bray's gas jet. This is not lighted, but it acts as a regulator, as not more than six feet per hour will pass through and be consumed under ordinary pressures. Above the atmospheric burner is an inverted fluted cone of cast iron, which becomes intensely heated when the gas is lighted. This cone is encased in an iron cover to prevent loss of heat. Above this are other cones and fluted passages, all of which present collectively a very large area of heated surface. The sewer gas enters from below, and passes up through and around the burner; and while some of it is immediately burned, the whole of the remainder must come into contact with the hot iron cones, and before it passes away into the upper part of the shaft is deprived of all vital particles injurious to health. It is stated that all germs, &c., are destroyed from the fact that the first cone has a heat which will melt lead, therefore it is at least 630° Fahrenheit—a temperature much higher than is necessary, and that in addition, the particles have to take a tortuous course through the intricacies of the cones and chambers, the detention being sufficiently long to prevent the possibility of anything escaping destruction.

At one time the draught frequently extinguished the flame, but this has now been remedied, and there can be no doubt that under certain conditions and in special cases this invention is of considerable value; but the cost amounting to five or six pounds a year for consumption of gas alone, makes their universal adoption almost prohibitive.

In the year 1887 Mr. McCallum introduced a system which is described as follows:

"The air current is caused by utilising a natural force which has always existed in sewers, but has hitherto remained

neglected and unrealised, viz., the running sewage. The air coming in contact with the more powerful element is compelled to travel in the same direction as the flow of water. In order to 'harness' this power the sewers are diverted into sections by means of a simple contrivance of peculiar construction which allows sewage to pass, but not air; and at each end of such a section a shaft is carried to the surface of the street and finished with a grating—one acting as a fresh air inlet and the other as outlet. Constant circulation of air and oxidation of gas is thus insured, and the dividing of sewers into sections, it is contended, prevents foul gas from the low part of a town being forced along sewers to a high part, or *vice versâ*." *

In 1889 Messrs. Ford and Wright of Portsmouth patented a system for ventilating sewers and drain pipes which may be described as follows:

Provision is made at or near the intrados of the sewer of a special air passage consisting of tubes partially disjointed or disconnected at intervals on the "tuyere" principle. Air is forced through these tubes from an adjacent manhole by means of a finely-divided spray of water which is known to thus carry large quantities of air with it, the water being afterwards used for flushing. The special feature of this invention consists in the open tubes at the summit of the sewer through which the air is forced; it being contended that an induced current is thus set up in the air of the sewer which passes through the openings into the tube and away into the open air at any convenient and safe height, in addition to which the introduction of large quantities of cold air into the sewer being highly beneficial to it. In an application I made of this patent at Portsmouth, the special air passage was formed of tapering galvanized steel tubes, averaging $5\frac{1}{2}$ inches diameter and 2′ 6″ long, suspended from the crown of the sewer. With a jet consuming only 23 gallons of

* *Vide* 'The Contract Journal,' June 29th, 1887, p. 810.

water an hour a constant down-current of air was maintained, varying from 330 to 390 feet a minute, equivalent to about 4500 cubic feet per hour, which diluted the sewer air, and by induced current changed the air of the sewer, a 4-foot tunnel, about once every hour. These results show that for each cubic foot of water used 1246 cubic feet of air were introduced into the air passage.

I have in this chapter attempted to give a short list of some of the principles which have from time to time been applied for the purpose of sewer ventilation; a summary of them and others may be given as follows:

Untrapped gullies at sides of streets, open gratings in centres of streets, open shafts carried up adjoining buildings, similar shafts furnished with intake and uptake cowls of many descriptions, furnaces and chimneys to be utilized, electric and galvanic action of the sewage or upon the air in sewers, passing the air over or through trays and baskets of different forms filled with charcoal, introduction of trays filled with chemical compounds, attempting to localise and sectionise ventilation in a similar manner to that of mines, the introduction of air either by propellors or by sprays of water, absorption of the gases by the superincumbent earth, using all house drains as ventilators, using all rain-water down pipes for a similar purpose, hollow lamp columns, special mechanical and other appliances, and many other systems and experiments too numerous to mention.

Having thus far considered some of the known methods for dealing with the noxious emanations which proceed from sewers, the next point to consider is what these noxious emanations are, and whether they exist in all sewers.

It has been found that, even in sewers of the best and most modern construction, what is called "sewer gas" is generated in more or less quantity; this arises even from fresh sewage, but is far more noxious and dangerous to health when the sewage has begun to decompose. Even where the

sewers are so constructed as to remove all the sewage to the outfall within 24 hours (which has been decided to be the maximum time it should take), there is still an accumulation of slime on the inner periphery of the sewers, owing to the rise and fall of the sewage line, which by leaving a deposit on the sides of the sewer is constantly manufacturing gases of decomposition.

It is no doubt true that the more perfect the system of sewerage is, the less foul air there is in the sewers; but in very few towns will there be found sewers or drains where gases are not generated, which then find their way into other parts of the sewage system unless they are dealt with in some effective manner.

Some difference of opinion exists as to what is the actual composition of this foul air in a sewer; but it is now almost universally admitted that it is highly dangerous to health if breathed, and is also sometimes very offensive.*

"The fœtid organic vapour," or sewer gas proper, has for its companions in a sewer, sulphuretted hydrogen, a most poisonous as well as unpleasant smelling gas, carburetted hydrogen, due very often to leaky gas mains or services, or to decomposing vegetable matters, carbonic acid gas or carbonic anhydride (choke damp), and some ammoniacal compounds.

The actual component parts, however, of any gases in a sewer must vary considerably with its conditions and locality,

* In 1887, Professor Carnelley and Dr. Haldane contributed a paper to the Royal Society on the subject of the air of sewers in which they gave the results of examinations which they had made upon the air of sewers in Dundee by which they found that the carbonic acid was twice, and the organic matter three times more in the outside atmosphere than in the sewers, and that the micro-organisms were less! Also that the air in these sewers was in a better chemical condition than that of naturally ventilated schools. They also stated that the micro-organisms in sewer air came entirely (or nearly so) from the outside; as from their experiments they found that the number *increased* with the ventilation of the sewer, and that the state of filthiness of a sewer seemed to have no effect on the number of micro-organisms. (*Vide* 'The Chemical News,' vol. lv. No. 1439, p. 288.)

&c., in the same manner as they would in any public building or room, and it is impossible to tell, without costly experiments, what gases may be prevalent in any particular portion of a sewer. But whatever may be the analysis of this foul air, there can be but little doubt that it contains organic matter floating about in it as solids, and that it is excessively injurious and even dangerous to breathe, and that it should be caught and destroyed or rendered innocuous, and not be permitted to pass into and contaminate and poison the air we breathe.*

Considerable difference of opinion has existed as to the movements of air in sewers, some engineers contending that it always found its way to the higher parts of the sewerage system; others that it was carried with the flow of sewage down the sewers; others that it varied with the rise and fall of the thermometer or barometer, etc. Mr. W. Santo Crimp, the then surveyor of Wimbledon, however, has carried out the most exhaustive series of experiments upon this question that have yet been tried, with the result that "throughout the entire series of experiments he found beyond all question that the wind was the only agent causing movements of sewer air that could be recorded by an anemometer, and that

* Mr. Read, the City Surveyor of Gloucester, gives the names of the gases and their specific quantities as compared with hydrogen and atmospheric air which are found in sewers as follows:

Gas	Specific Gravity.
Hydrogen	1·00
Atmospheric air	14·25
Sulphuretted hydrogen	17·00
Carburetted hydrogen	8·00
Olefiant gas	13·00
Ammonia	8·50
Carbonic acid	22·00
Nitrogen	13·85
Sulphurous acid	32·00
Bisulphide of carbon	38·00
Chlorine	35·50
Watery vapour	9·00

(*Vide* 'Minutes of Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. ix. p. 35.)

the currents were uphill or downhill accordingly as the individual sewer experimented upon was affected by the wind."*

The whole subject of scientific and sanitary sewer ventilation is beset with difficulties, as will be seen by my readers when I tell them that since the year 1887 this question has been before the Council of the Association of Municipal and Sanitary Engineers and Surveyors (now called the Association of Municipal and County Engineers) with a view to some more definite solution of the question, and up to the present date no report has yet been issued.

Whatever system of ventilation of the main sewers in any town may be adopted, it is imperative that the houses connected with them should be properly trapped, ventilated, and "isolated," and this is in my judgment of even greater importance than the ventilation of the main sewers. Upon this point I shall endeavour to give further information in the chapter on "House Drainage."

* *Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. xvi. p. 13.

CHAPTER XXIII.

PUBLIC CONVENIENCES.

IN almost every town in the United Kingdom public urinals are now erected, and within recent years water-closet accommodation has also in many cases been provided, principally owing to the introduction of underground conveniences.

The clause of the Public Health Act which empowers an urban authority to spend money out of the district rates for this purpose is as follows:

"Any urban authority may if they think fit provide and maintain in proper and convenient situations, urinals, water-closets, earthclosets, privies and ashpits and other similar conveniences for public accommodation" (38 & 39 Vic. c. 55, s. 39).*

It is not my intention to enter into the merits or otherwise of the many descriptions of urinals and latrines that have been brought to the notice from time to time of every town surveyor by enterprising manufacturers and patentees, but only to give a few suggestions upon the subject.

Public urinals and conveniences ought to be erected by the urban authority as a matter of convenience to the peripatetic portion of any community, and also to prevent nuisances being committed in improper places.

* The Public Health Acts Amendment Act, 1890, to which reference has before been made, contains the following clause in connection with public conveniences:

(1.)—Where an urban authority provide and maintain for public accommodation any sanitary conveniences, such authority may—

(i.) Make regulations with respect to the management thereof, and make byelaws as to the decent conduct of persons using the same;

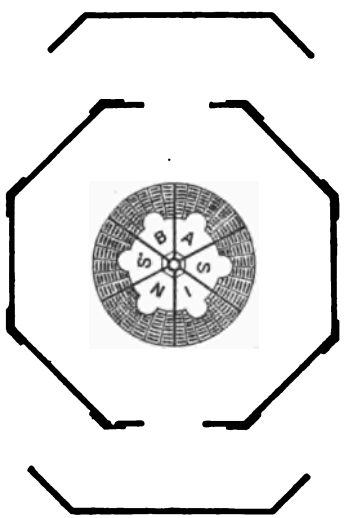
(ii.) Let the same from time to time for any term not exceeding three years at such rent and subject to such conditions as they may think fit;

(iii.) Charge such fees for the use of any waterclosets provided by them as they may think proper. (53 & 54 Vic. c. 59, Part III. sec. 20.)

In selecting sites for urinals and conveniences, the town surveyor must take care that after erection they shall not be offensive or a nuisance to any persons living in the vicinity, and that they shall be so placed that although they may be easily found, the persons using them shall be effectually screened.*

Urinals which are erected above ground are better constructed of iron, rather than of brickwork or more solid workmanship, in order that they can be readily removed. It is surprising what an uproar is sometimes raised in a neighbourhood by the erection of a urinal; this clamour occasionally has so much effect upon the urban authority that they order the removal of the urinal, although it may not have been erected many days, and if it has been substantially built a considerable waste of the public money is thus involved.

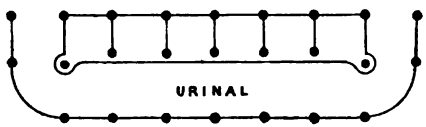
Where a urinal is constructed with basins, as by the following plan, the basins may be of iron or good stoneware



* The urban authority have an absolute discretion as to the sites they select. They cannot, however, erect public conveniences so as thereby to cause a nuisance, even though the convenience is wanted and the locality chosen suitable. (*Vide* 'Public Health and Local Government Act,' by F. V. Fitzgerald, 3rd edition, p. 33.)

or similar construction, these being always kept full of water which is constantly although slowly changing.

Stall urinals may be some modification of the following plan, and be constructed of iron with slate partitions, or the



partitions may be of iron covered with slate where soiled, the stalls should not be less than 24 in. in the clear, and water must be kept constantly flowing over the soiled portion either from a perforator pipe or a spreader.* A very excellent arrangement is to have a trench or trough cut at the foot of the stall for the whole length of the urinal, which is kept constantly full of water and occasionally flushed, thus avoiding nuisance in a very satisfactory manner.

Urinals are now also constructed on the "trough" principle, or "basin" principle, the following being a description of this arrangement as carried out by George Jennings, the well-known Sanitary Engineer. The basin, holding about 6 gallons, is arranged to stand full of water, retained by a ground-in gun-metal discharge plug or standing waste, in a gun-metal seating. This plug, being hollow, at all times regulates the height of the water within the pan, so that, should a constant change or current be desired, the supply valve or stop-cock may be left partially open, without the possibility of overflow.

The discharge plug should be raised once or twice a day, oftener if the urinal is much used. The contents pass direct into a semicircular basin rendered in cement (or formed in lead on wood floors), which drains the foot grating supporting the urinal; in the bottom of this basin should be fixed a 4-in.

* The quantity of water usually required to each stall when kept constantly running is about half a gallon per minute.

stoneware syphon trap, the whole being thoroughly flushed at each discharge, and all refuse matter carried away as effectually as from a water-closet.

Nothing takes the sting of offence from urine like a body of water; hence the superiority of these urinals over the plain slabs and apron-pieces, or iron-stalls, which offer a large, impure, and constantly fouling and evaporating surface, which no waste of water can cleanse or render inoffensive.

Provision must of course be made to efficiently drain and light all public urinals, and arrangements should be made by which they can be thoroughly washed once or twice a day, so as to keep every part scrupulously clean. Urine after a very short exposure exhales a most fœtid and unpleasant odour, from the decomposition of its nitrogenous matter. Carbolic acid, chloride of lime, or other disinfectant should also be used, especially in warm weather.

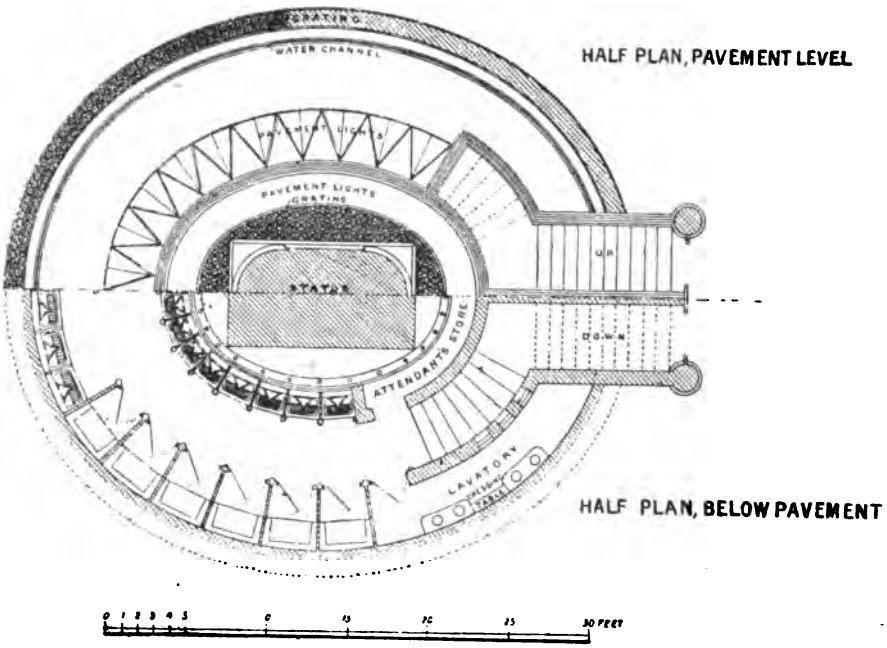
If the interior of a public urinal or latrine has to be painted a light colour, it is well to mix a little sand with the paint, so as to prevent as much as possible that literature and art which so often disfigures establishments of this description. An excellent composition with which to treat urinals, although it is of a somewhat dark tint, is a mixture of common coal tar and naphtha, which not only gives a clean and polished appearance to the place, but is also an excellent deodorant and disinfectant.

With regard to the provision of public W. C. accommodation by local authorities, this has become far more general within recent years now that this accommodation and that of urinals can be provided underground. The first attempt to provide anything of the kind was successfully made by Mr. Haywood, the Engineer to the City of London Commissioners of Sewers, who constructed one near the Royal Exchange, London. The following sectional plan if it may be interesting, though it is probably well known by most of my readers.

Since the construction of this convenience, others have

rapidly followed, both in the metropolis and elsewhere, as their advantages are very obvious.

They are unobtrusive, there being no external evidence of them other than that of steps guarded by ornamental gates and railings, and probably a lamp column over the centre, and without entering into any details of their construction, the following few hints may be useful.



Make sure the sewer is deep enough to drain the convenience, and that there will be no back flooding.*

Give sufficient head room and provide for efficient lighting by deck lights or otherwise, and see that the ventilation is abundant. Line the whole structure with white glazed bricks, and in order that these may preserve their colour below

* Provision can be made against back flooding by the use of a special "Jennings" back pressure trap.

ground, it is well to take special precautions in wet or damp soils to encase the structure within outer walls.

Only the best apparatus of all kinds should be used in an underground convenience for obvious reasons, and the whole place should be easily cleansed by the attendant. The floor may be of asphalte or cement, and all the woodwork should be varnished pitch pine.

Provision for lighting after dark must be provided, and a gas stove for warming at night, care being taken to remove the fumes arising from the gas jets in all cases.

Where it is wished to avoid the expense of an attendant, the "Penny in the slot" principle has been attempted, but with doubtful success, as unscrupulous persons are liable to tamper with the cash box as well as the apparatus.

For any further information upon the subject of urinals, waterclosets, latrines, or conveniences of all descriptions, I cannot do better than refer the Town Surveyor to Mr. George Jennings, or Messrs. MacFarlane, who have an endless variety of designs and appliances in connection with such matters.

CHAPTER XXIV.

ARTIZANS' AND LABOURERS' DWELLINGS, ETC.

IN the first edition of this book one of the most difficult chapters to write was that upon the subject of the laws relating to the subject of artizans' and labourers' dwellings, as no less than ten different Acts of Parliament then existed which were in some of their clauses contradictory, complex, and confusing to understand. Since that chapter was written, the Housing of the Working Classes Act 1890 (53 & 54 Vict. ch. 70), has become law, and has repealed or amended nearly the whole of the ten previous Acts, and has consolidated the numerous statutes bearing upon this subject. In a "memorandum" from the Local Government Board upon this Act, published in October 1890, appears the following:

"These amendments have very materially simplified the procedure to be taken by local authorities with a view to the closing and demolition of dwelling-houses unfit for human habitation; and have given facilities for the making and carrying out of schemes for the reconstruction and rearrangement of insanitary buildings on a smaller scale than those contemplated by the Artizans' and Labourers' Dwellings Improvement Acts, and by a less elaborate machinery than was contained in those Acts. They have provided safeguards against the payment of excessive compensation in respect of dwellings which have been allowed to get into a state of defective sanitation or into bad repair, or the rentals of which have been enhanced by over-crowding, or by the houses being used for illegal purposes. They have enabled the expenses of arbitrations to be diminished in certain cases; and have exempted the local authorities from the payment of the

expenses of owners in respect of arbitrations in cases where such particulars of claims have not been delivered prior to the appointment of the arbitrator as would have enabled the local authority to make proper offers of compensation. They have empowered courts of summary jurisdiction, when making orders for the closing of houses unfit for human habitation, to authorise the payment to the tenants of a reasonable allowance on account of their expenses in removing, which will be recoverable from the owners of the houses; and they have enabled the local authorities to make similar payments to the tenants of house who are required to give up possession when the houses are to be pulled down for the purpose of improvement schemes. They have also made numerous other alterations in the law with a view to strengthening the hands of the local authorities and facilitating the due execution of the Act."*

The Act is divided into seven parts, of which the first deals with unhealthy areas, and the schemes to be carried out by local authorities for their improvement.† The act is silent as to what officer of the local authority is to prepare the Scheme; for although the Medical Officer of Health is frequently mentioned, and it is only upon his representation that the local authority can act in the matter, it is unlikely that this officer would be competent to prepare a complicated scheme "for the rearrangement and reconstruction of the streets and houses within such area" (53 & 54 Vict. ch. 70, sect. 4).

This assumption is confirmed by Sect. 6 of the Act, which is as follows:

"(1.) The improvement scheme of a local authority shall be accompanied by maps, particulars and estimates, and

(*a.*) may exclude any part of the area in respect of which

* *Vide* Memorandum on the Housing of the Working Classes Act, 1890 (53 & 54 Vict. ch. 70) signed Hugh Owen, Secretary Local Government Board, Whitehall, London, S.W., October, 1890.

† This part of the Act does not apply to Rural Sanitary Districts.

an official representation is made, or include any neighbouring lands, if the local authority are of opinion that such exclusion is expedient or inclusion is necessary for making their scheme efficient for sanitary purposes; and

(*b.*) may provide for widening any existing approaches to the unhealthy area, or otherwise for opening out the same for the purposes of ventilation or health; and

(*c.*) shall provide such dwelling accommodation, if any, for the working classes displaced by the scheme, as is required to comply with this Act;* and

(*d.*) shall provide for proper sanitary arrangements.

(2.) The scheme shall distinguish the lands proposed to be taken compulsorily.

(3.) The scheme may also provide for the scheme or any part thereof being carried out and effected by the person entitled to the first estate of freehold in any property comprised in the scheme or with the concurrence of such person, under the superintendence and control of the local authority, and upon such terms and conditions to be embodied in the scheme as may be agreed upon between the local authority and such person." (53 & 54 Vict. ch. 70, sec. 6.)

It may then, I conclude, be assumed that the preparation of the above scheme rests with the town surveyor, and these words, so easily written, mean a very large addition to the duties of this already overworked officer.

After the scheme has been prepared, the local authority

* Where a scheme comprises an area situate elsewhere than in the county or city of London, it shall, if the confirming authority so require (but it shall not otherwise be obligatory on the local authority so to frame their scheme), provide for the accommodation of such number of those persons of the working classes displaced in the area with respect to which the scheme is proposed in suitable dwellings to be erected in such place or places either within or without the limits of the same area as the said authority, on a report made by the officer conducting the local inquiry, may require. (53 & 54 Vic. c. 70, sec. 11, sub-sec. 2.) A local authority may, for the purpose of providing accommodation for persons of the working classes displaced by any improvement scheme, appropriate any lands for the time being belonging to them which are suitable for the purpose, or may purchase by agreement any such further lands as may be convenient. (53 & 54 Vic. c. 70, sec. 32.)

must obtain a provisional order for the purpose of carrying it out; but it would occupy too much space to give in detail the work which is necessary in the way of plans, estimates, statistics and evidence for the surveyor to prepare in order to obtain this provisional order.

The compensation clauses of the Act are especially interesting and are given *in extenso.*

"(1.) Whenever the compensation payable in respect of any lands or of any interests in any lands proposed to be taken compulsorily in pursuance of this part of this Act requires to be assessed—

(*a.*) the estimate of the value of such lands or interests shall be based upon the fair market value, as estimated at the time of the valuation being made of such lands, and of the several interests in such lands, due regard being had to the nature and then condition of the property, and the probable duration of the buildings in their existing state, and to the state of repair thereof, without any additional allowance in respect of the compulsory purchase of any area or of any part of an area in respect of which an official representation has been made, or of any lands included in a scheme which, in the opinion of the arbitrator, have been so included as falling under the description of property which may be constituted an unhealthy area under this part of this Act; and

(*b.*) in such estimate any addition to or improvement of the property made after the date of the publication in pursuance of this part of this Act of an advertisement stating the fact of the improvement scheme having been made shall not (unless such addition or improvement was necessary for the maintenance of the property in a proper state of repair) be included, nor in the case of any interest acquired after the said date shall any separate estimate of the value thereof be made so as to increase the amount of compensation to be paid for the lands; and

(2.) On the occasion of assessing the compensation payable under any improvement scheme in respect of any house or premises situate within an unhealthy area evidence shall be receivable by the arbitrator to prove—

(1st) that the rental of the house or premises was enhanced by reason of the same being used for illegal purposes, or being so overcrowded as to be dangerous or injurious to the health of the inmates; or

(2ndly) that the house or premises are in such a condition as to be a nuisance within the meaning of the Acts relating to nuisances, or are in a state of defective sanitation, or are not in reasonably good repair; or

(3rdly) that the house or premises are unfit, and not reasonably capable of being made fit, for human habitation;

and, if the arbitrator is satisfied by such evidence, then the compensation—

(*a.*) shall in the first case so far as it is based on rental be based on the rental which would have been obtainable if the house or premises were occupied for legal purposes, and only by the number of persons whom the house or premises were, under all the circumstances of the case, fitted to accommodate without such overcrowding as is dangerous or injurious to the health of the inmates; and

(*b.*) shall in the second case be the amount estimated as the value of the house or premises if the nuisance had been abated, or if they had been put into a sanitary condition, or into reasonably good repair, after deducting the estimated expense of abating the nuisance, or putting them into such condition or repair, as the case may be; and

(*c.*) shall in the third case be the value of the land, and of the materials of the buildings thereon." (53 & 54 Vict. ch. 70, sec. 21.)

"Upon the purchase by the local authority of any lands

required for the purpose of carrying into effect any scheme, all rights of way, rights of laying down or of continuing any pipes, sewers, or drains on, through, or under such lands, or part thereof, and all other rights or easements in or relating to such lands, or any part thereof, shall be extinguished, and all the soil of such ways, and the property in the pipes, sewers, or drains, shall vest in the local authority, subject to this provision, that compensation shall be paid by the local authority to any persons or bodies of persons proved to have sustained loss by this section, and such compensation shall be determined in the manner in which compensation for lands is determinable under this part of this Act, or as near thereto as circumstances admit." (53 & 54 Vict. ch. 70, sec. 22.)

The second part of the Act deals with unhealthy dwellings, and gives sanitary authorities very important powers and duties in relation to the closing and demolition of dwelling-houses unfit for human habitation; the pulling down and the acquisition of the sites of obstructive buildings, and the making and carrying out of schemes for improvement of areas which are too small to be dealt with under Part I. of the Act.

Here again it is the duty of the Medical Officer of Health (or of any officer of such authority)* to call the attention of the authority to any dwelling house "in a state so dangerous or injurious to health as to be unfit for human habitation;"† and proceedings are then taken, first to close and then to demolish or render the house fit for human habitation. As in the latter case the surveyor appears by name for the first and only time in the Act, I give that portion of the section of the Act in full, leaving it to my readers to find out for themselves the best method for ascertaining the value of the "charging order";

"Where any owner has completed in respect of any dwelling-house any works required to be executed by an order of a local authority under this part of this Act, he may apply

* *Vide* 53 & 54 Vic. c. 70, sec. 32. † *Ibid.*

to the local authority for a charging order, and shall produce to the local authority the certificate of their surveyor or engineer that the works have been executed to his satisfaction, and also the accounts, of and vouchers for, the costs, charges, and expenses of the works, and the local authority, when satisfied that the owner has duly executed such works and of the amount of such costs, charges, and expenses, and of the costs of obtaining the charging order which have been properly incurred, shall make an order accordingly, charging on the dwelling-house an annuity to repay the amount." (53 & 54 Vic. ch. 70, sec. 36.)

Where a building has been taken down and removed under the above provisions, no house or other building or erection may be erected on all or any part of the site of the building which is dangerous or injurious to health. Full power is given to the sanitary authority to enforce compliance with this requirement. *

What are known as "obstructive buildings" may also be pulled down under this part of the Act after certain formalities have been gone through, and compensation based on the same conditions as those I have already quoted has been paid to the owner.

The third part of the Act consolidates the Labouring Classes Lodging Houses Acts, 1851 to 1885, commonly known as Shaftesbury's Acts. This part of the Act may be adopted by any urban sanitary authority for their district.† When it has been adopted it empowers the urban sanitary authority to provide "lodging houses for the working classes," which expression includes separate houses or cottages for the working classes, whether containing one or several tenements.

* This seems an almost unnecessary provision, for byelaws regulating "new buildings" exist in nearly all towns, and the re-erecting of any building pulled "down to or below the ground floor, etc." . . . . shall be considered the erection of a new building (38 & 39 Vic. c. 55, sec. 159).

† A Rural Sanitary Authority may adopt this part of the Act by application under certain conditions to its County Council. (53 & 54 Vict. ch. 70, sec. 55.)

For this purpose it empowers the authority to purchase or rent land, or, with the consent of the board, to appropriate any land for the time being vested in them or at their disposal, and on such land to erect any buildings suitable for lodging houses for the working classes, and to convert any buildings into lodging houses for those classes, and to alter, enlarge, repair, and improve the buildings, and to fit up, furnish, and supply them with the requisite furniture, fittings, and conveniences. It also enables the urban sanitary authority to contract for the purchase or lease of any lodging houses for the working classes already or hereafter to be built and provided, and, with the consent of the Board, to appropriate the same for the purposes of this part of the Act, and to sell, with the consent of the Board, any land vested in them for these purposes, and to apply the proceeds in or towards the purchase of other more suitable lands.

The short allusions which I have made to this Act have only been made in order that I might draw attention to the alteration of the law since the first edition of this book was published, and I will now proceed to repeat what I said then with reference to the buildings which are generally erected under such a "scheme" as is mentioned in the first part of the Act.

The buildings which are erected on the sites dealt with under this Act are generally of the "high block" class, as it is found that the labouring man prefers to live near his work, and land is generally too expensive in such localities to admit of the erection of any other description of buildings.

As to whether this class of dwelling is as healthy as ordinary cottages or houses, the following death-rates for the year 1879 will be some guide:

The London Improved Industrial Dwellings	16·4 per 1000
The Peabody Trust Dwellings	17·2 ,, ,,
The Metropolitan Association Dwellings	14·3 ,, ,,
The Newcastle Improved Industrial Dwellings ..	12·0 ,, ,,
The general death rate for the Metropolis at the same date being	21·2 ,, ,,

It is of course necessary that the sanitary arrangements of industrial dwellings of the block type should be very perfect, and as to the manner in which they should be erected the following words of Mr. John Price, who for twelve years had lived in one of them himself, can be here given with advantage: *

"Model dwellings are therefore most appreciated by working men when placed near the scene of their daily labour. The arrangements most preferred are those which bring the fewest families or persons in contact with one another on a flat or landing. As a rule, the buildings should not exceed four stories in height; the staircases should be about four feet in width, and broken by short landings, lighted by large windows open to the external air; the window-sills should not be less than three feet from the floors for the safety of young children, and for the same reason well staircases should be avoided. The steps of the stairs should only have a 6-inch 'rise,' for the more easy accommodation of old people and young children; they should be fire-proof, and well lighted with gas on an evening. There should be a thick layer of deafening between the floors. The waterclosets should be placed in an offshoot from the main building, opening on to each landing, and well ventilated by open windows and air bricks. The watercloset apparatus should be as simple and effective as possible. Patents depending upon the proper working of valves and ball-cocks should be avoided, as the fruitful cause of trouble and expense; little reliance must be placed on their proper use by tenants where more than one family have access to them. I have seen excellent closets stopped up with cloths and all manner of earthenware and hardware, children of careless parents being the principal offenders; what is everybody's duty is often most neglected. It will be found most economical in large buildings of this

* *Vide* 'Industrial Dwellings from a Sanitary point of View,' by John Price, Resident Agent, Newcastle-on-Tyne Industrial Dwellings Company, read September 28th, at the Congress of the Institute, held at Newcastle-on-Tyne.

class to appoint a person whose duty it should be to attend to the proper flushing of waterclosets daily. I would suggest that there should be a large cistern under the roof (distinct from the cistern used for domestic purposes), a ¾-inch feed pipe should lead to each W.C., which should consist of a simple metal or earthenware pan, provided only with a tap, flushing rim, and plug, placed under the seat securely, and under the sole control of the attendant, who, by the necessary daily inspection, would detect any stoppage or injury to the fittings. The expense of such supervision would probably be soon saved in plumber's bills. Of course the soil-pipes should be well ventilated above the roof of the building, and all drains and sinks should be properly trapped. The attendant on his daily rounds would also be able to see that these are kept in proper order. The dust-shaft, extending to the full height of the building, should have proper hoppers connected with it to prevent the dust coming from the lower or upper landings—a nuisance sometimes complained of in block dwellings. The washhouses should be placed on the roof or in the yards, fitted with set pots and requisite conveniences. The soft water from the roofs should be stored in tanks for washing and domestic purposes—it will be much appreciated by sensible tenants, and save the water bill greatly.

"The great desiderata of these large blocks of buildings is ample playground for the children, without which they play upon the stairs, and are often the cause of strife amongst neighbours. I know those who have experience in the matter may say that it is more easy to state what is desirable than what is practical. The enhanced value of land in all our large towns precludes any liberal investment on what appears so financially unremunerative as playgrounds, yet they are essential adjuncts wherever there is an infantile population. Mr. Powell, on behalf of the London Trades' Unions, enumerated before Sir Richard Cross's Committee certain objections which the working classes of London entertained against the

earliest erected blocks of dwellings, amongst which was their barrack-like and uninviting appearance, and also their want of playgrounds for children. Recently these defects have been greatly remedied."

The following copy of the byelaws as sanctioned by the Treasury in 1867 in connection with the Labouring Classes' Lodging Houses Acts (14 & 15 Vic. c. 34; 29 & 30 Vic. c. 28; 30 & 31 Vic. c. 28) may be of interest, and also the table of sizes of rooms which follows may be useful.

"Separate watercloset accommodation to be provided for each tenement, or else, where watercloset accommodation is to be used in common by the occupants of two or more tenements, separate accommodation must be provided for each sex. Such accommodation may be either watercloset, earthcloset, or privy.

Each tenement to have a dustbin or the use of a dustbin common to several buildings.

Each tenement to be well lighted by external windows made to open.

Each tenement to have ready access to water.

Where several tenements in one building, proper ventilation to be provided for the passages, staircases, &c.

The drains to be well constructed.

Parties to whom moneys to be advanced to enter into covenants with the Public Works Loan Commissioners, that where there are several tenements in one building they;

(*a.*) Will cause the passages, staircases, &c., to be kept clean;

(*b.*) Will cause the waterclosets, &c., to be kept in good repair;

(*c.*) Will cause the dustbins to be emptied at intervals of seven days;

(*d.*) Will take precautions against any interruption in the supply of water;

(*e.*) Will keep the windows in good order and repair, and the chimneys swept;

(*f.*) Will keep the drains in proper order;

(*g.*) Will allow inspection by Commissioner of Works to see that the above covenants are observed.

Number of cubic feet in each room of the several classes of tenements (none of less than two rooms) for which money has been authorised to be advanced:"

Class.	One Room of cubic feet.	One Room of cubic feet.	One Room of cubic feet.	One Room of cubic feet.	One Room of cubic feet.
Class I. of two rooms	715	1,219			
Ditto	816	994			
Ditto	995	1,020			
Class II. of four rooms	960	960	960	960	
Class III. of five rooms.. ..	372	675	1,056	1,056	1,232
Ditto	446	459	459	781	1,468

It may be information valuable to a town surveyor, if before closing this chapter I draw attention to the provisions of the Municipal Corporations Act 1882 (45 & 46 Vic. c. 50, s. 3), which gives corporations power to convert any corporate land into sites for working men's dwellings, although the corporation are not authorised to erect dwellings thereon, and this section does not seem to have been repealed by the Housing of the Working Classes Act 1890, to which I have referred.

CHAPTER XXV.

DEFECTS IN DWELLING-HOUSES, ETC.

THERE are many defects in dwelling-houses with which it is the duty of the sanitary inspector to deal, such as the Bake-house Regulations Act, offensive trades, nuisances rendering houses unfit for human habitation, &c. ; but I propose to give in this chapter, in addition to those with which I have already dealt, such subjects under this head as come within the duties of the town surveyor.

The first which I propose to treat is that of the question of—

Cellar Dwellings.—These are at all times objectionable, even if the clauses of the Public Health Act 1875 be strictly carried out, and the surveyor should discourage them as much as possible. Nothing more can be said with reference to them than is contained in the provisions of the above Act, which are as follows : *

"It shall not be lawful to let or occupy or suffer to be occupied separately as a dwelling, any cellar (including for the purposes of this Act in that expression any vault or under-ground room) built or rebuilt after the passing of this Act, or which is not lawfully so let or occupied at the time of the passing of this Act" (38 & 39 Vic. c. 55, s. 71).

And with regard to existing cellar dwellings they are only to be let or occupied on the following conditions :—

"Unless the cellar is in every part thereof at least seven feet in height, measured from the floor to the ceiling

* Any cellar in which any person passes the night shall be deemed to be occupied as a dwelling within the meaning of this Act (38 & 39 Vic. c. 55, s. 74).

thereof, and is at least three feet of its height above the surface of the street or ground adjoining or nearest to the same; and

"Unless there is outside of and adjoining the cellar and extending along the entire frontage thereof, and upwards from six inches below the level of the floor thereof up to the surface of the said street or ground, an open area of at least two feet and six inches wide in every part; and

"Unless the cellar is effectually drained by means of a drain, the uppermost part of which is one foot at least below the level of the floor thereof; and

"Unless there is appurtenant to the cellar the use of a watercloset, earthcloset, or privy, and an ashpit, furnished with proper doors and coverings, according to the provisions of this Act; and

"Unless the cellar has a fireplace with a proper chimney or flue, and an external window of at least nine superficial feet in area clear of the sash frame, and made to open in a manner approved by the surveyor (except in the case of an inner or back cellar let or occupied along with a front cellar as part of the same letting or occupation, in which case the external window may be of any dimensions, not being less than four superficial feet in area clear of the sash frame).

"Provided that in any area adjoining a cellar there may be steps necessary for access to such cellar, if the same be so placed as not to be over, across, or opposite to the said external window, and so as to allow between every part of such steps and the external wall of such cellar a clear space of six inches at the least, and that over or across any such area there may be steps necessary for access to any building above the cellar to which such area adjoins, if the same be so placed as not to be over, across, or opposite to any such external window" (38 & 39 Vic. c. 55, s. 72).

Where two convictions in respect of the same cellar have taken place within three months, the local authority may close

it, and recover any expenses incurred by them in the execution of this duty (38 & 39 Vic. c. 55, s. 75).

The next defect in a dwelling-house which will be considered is that of—

Insufficient W.C. accommodation.—A new house may not be erected without "a sufficient watercloset, earthcloset,* or privy" under a penalty not exceeding twenty pounds† (38 & 39 Vic. c. 55, s. 35).

And with regard to existing premises:

"If a house within the district of a local authority appears to such authority by the report of their surveyor or inspector of nuisances to be without a sufficient watercloset, earthcloset, or privy . . . . the local authority shall by written notice require the owner or occupier of the house within a reasonable time therein specified, to provide a sufficient watercloset, earthcloset, or privy . . . . or either of them as the case may require. If such notice is not complied with the local authority may, at the expiration of the time specified in the notice, do the work, provided that where a watercloset, earthcloset, or privy has been and is used in common by the inmates of two or more houses, or if in the opinion of the local authority a watercloset, earthcloset, or privy, may be so used, they need not require the same to be provided for each house" (38 & 39 Vic. c. 55, s. 36).

If the local authority approve, an earthcloset may be constructed instead of a watercloset, but in this case they should make arrangements for the supply of the dry earth and the removal of its contents.

The necessary form of notice to be served in connection with insufficient W.C. accommodation may be as follows:

* "In this Act (P. H. Act 1875) the term 'earth closet' includes any place for the reception and deodorization of fæcal matter constructed to the satisfaction of the local authority" (38 & 39 Vic. c. 55, s. 37).

† In case of several houses together, it has been held as not necessary to have separate accommodation for each house, if there is sufficient for them collectively. (Clutton Guardians *v.* Pointing, 4 Q. B. Division 340, 48 L. J. M. C. 137.)

To the owner of the house No. *in the borough of*

Whereas the above-mentioned house is situate within the district of the mayor, aldermen, and burgesses of , the urban sanitary authority for the borough of : And whereas it appears to the said urban sanitary authority that the said house is without a sufficient watercloset, earthcloset, or privy: Now the said urban sanitary authority do hereby require you, the said owner, within from the date of this notice to provide a sufficient watercloset for the use of the inhabitants of the said house. And take notice, that if you do not within the time above specified provide a sufficient watercloset, as aforesaid, to the satisfaction of the said urban sanitary authority, they will themselves, at the expiration of such time, do the necessary work to provide such closet accommodation as aforesaid, and proceed to recover the costs and expenses thereby incurred in manner provided by the Public Health Act 1875.

Dated this of , 18 .

Surveyor to the said Mayor, Aldermen and Burgesses.

And where the case demands, the following note may be added below the above notice:

"NOTE.—The urban sanitary authority may, if they so determine, require a separate watercloset to be provided for each house, or they may permit a watercloset to be used in common by the inmates of two or more houses,* but in either case the closet itself must be properly constructed and provided with due means of ventilation. The urban sanitary authority will approve of the existing closet accommodation if it is perfected by means of the following works being carried out. (Specification of work required to be done must here be

* It is not always possible for a separate W.C. to be provided for each house, hence the wisdom of the law which makes it permissive for a local authority to allow a group of tenements to be provided for by several waterclosets close together.

inserted.) The whole of the work to be executed in a workmanlike manner and to my entire approval.

"It is, however, to be understood that the above notice requiring the work to be executed within one month will be rigidly enforced; and if at the expiration of that time the work be not completed, the urban sanitary authority will themselves proceed to execute the necessary work to provide proper closet accommodation in such manner as they may deem most advisable, without pledging themselves to the adoption of the method above suggested.

Surveyor to the said Mayor, Aldermen and Burgesses.

With regard to watercloset accommodation for factories, it appears to rest entirely with the town surveyor to draw the attention of the sanitary authority to any case where he considers this is deficient, as by the following clause:

"Where it appears to any local authority by the report of their surveyor that any house is used or intended to be used as a factory or building in which persons of both sexes are employed or intended to be employed at one time in any manufacture, trade, or business, the local authority may, if they think fit, by written notice require the owner or occupier of such house, within the time therein specified, to construct a sufficient number of waterclosets, earthclosets, or privies and ashpits for the separate use of each sex.

"Any person who neglects or refuses to comply with any such notice shall be liable for each default to a penalty not exceeding twenty pounds, and to a further penalty not exceeding forty shillings for every day during which the default is continued" (38 & 39 Vic. c. 55, s. 38). This section is repealed where the local authority have adopted Part 3 of the Public Health Acts Amendment Act 1890, the following being substituted:

"(1.) Every building, used as a workshop or manufactory, or where persons are employed or intended to be employed in

any trade or business, whether erected before or after the adoption of this part of this Act in any district, shall be provided with sufficient and suitable accommodation in the way of sanitary conveniences, having regard to the number of persons employed in or in attendance at such building, and also where persons of both sexes are employed, or intended to be employed, or in attendance, with proper separate accommodation for persons of each sex.

(2.) Where it appears to an urban authority on the report of their surveyor that the provisions of this section are not complied with in the case of any building, the urban authority may, if they think fit, by written notice, require the owner or occupier of any such building to make such alterations and additions therein as may be required to give such sufficient, suitable, and proper accommodation as aforesaid.

(3.) Any person who neglects or refuses to comply with any such notice shall be liable for each default to a penalty not exceeding twenty pounds, and to a daily penalty not exceeding forty shillings.

(4.) Where this section is in force, section thirty-eight of the Public Health Act 1875 shall be repealed" (53 & 54 Vic. c. 59 s. 22).

In providing closet accommodation which is to be used in common by the occupants of a number of houses, it must be remembered that it should be of the most simple description. Any one acquainted with the working of waterclosets situated in courts and alleys will know how badly they are treated, and into what a fearful state of disrepair and filth they speedily fall, as the great difficulty the sanitary inspector always finds is to have them kept clean. "What is everybody's business is nobody's." And although by clauses 40, 41, 46, &c., of the Public Health Act 1875 persons causing a nuisance can be punished, it is a difficult matter to detect the person in fault, unless of course it is a structural defect, when the owner can be summoned if it is allowed to remain uncured. To meet

this difficulty the Public Health Acts Amendment Act 1890 has the following clause:

"With respect to any sanitary convenience used in common by the occupiers of two or more separate dwelling-houses, or by other persons, the following provisions shall have effect:—

(1.) If any person injures or improperly fouls any such sanitary convenience, or anything used in connection therewith, he shall for every such offence be liable to a penalty not exceeding ten shillings.

(2.) If any sanitary convenience or the approaches thereto, or the walls, floors, seats, or fittings thereof is or are in the opinion of the urban authority or of the inspector of nuisances or medical officer of health of such authority in such a state or condition as to be a nuisance or annoyance to any inhabitant of the district for want of the proper cleansing thereof, such of the persons having the use thereof in common as aforesaid as may be in default, or in the absence of proof satisfactory to the court as to which of the persons having the use thereof in common is in default, each of those persons shall be liable to a penalty not exceeding ten shillings, and to a daily penalty not exceeding five shillings (53 & 54 Vic. ch. 59, s. 21).

The last point to consider in this chapter is that of *Houses without a proper supply of water.*

"Where on the report of the surveyor of a local authority it appears that any house is without a proper supply of water, and that such a supply can be furnished at a cost not exceeding that authorised by any local Act, or where there is not any local Act, not exceeding twopence a week, or at such other cost as the Local Government Board may determine, the local authority shall give notice in writing to the owner, requiring him, within a time specified, to obtain such supply, and to do all such works as may be necessary for that purpose,* and in

* A similar provision is made requiring the keeper of a common lodging house to obtain a proper supply of water (38 & 39 Vic. c. 55, s. 81), but it does not appear to be the express duty of the town surveyor to draw attention to this, as it does in the more general clause.

default of his doing so may carry out all necessary works themselves for obtaining such supply" (*vide* 38 & 39 Vic. c. 55, s. lxii.).

It is not very often that a house is found without any supply of water at all, for if that from the mains is not laid on it is generally found that the house is supplied from a well or from a stand-pipe in a court, or some similar source. If the water is derived from an impure well or other contaminated source, the following clause of the Public Health Act 1875, must be enforced in order to close the well or compel the discontinuance of the polluted supply, when a "proper" supply of water can be enforced in the manner I have described:

"On the representation of any person to any local authority that within their district the water in any well, tank, or cistern, public or private, or supplied from any public pump, and used or likely to be used by man for drinking or domestic purposes, or for manufacturing drinks for the use of man, is so polluted as to be injurious to health, such authority may apply to a court of summary jurisdiction for an order to remedy the same; and thereupon such court shall summon the owner or occupier of the premises to which the well, tank, or cistern belongs if it be private, and in the case of a public well, tank, cistern or pump, any person alleged in the application to be interested in the same, and may either dismiss the application, or may make an order directing the well, tank, cistern, or pump to be permanently or temporarily closed, or the water to be used for certain purposes only, or such other order as may appear to them to be requisite to prevent injury to the health of persons drinking the water.

"The court may, if they see fit, cause the water complained of to be analysed at the cost of the local authority applying to them under this section.

"If the person on whom an order under this section is made fails to comply with the same, the court may, on the applica-

tion of the local authority, authorise them to do whatever may be necessary in the execution of the order, and any expenses incurred by them may be recovered in a summary manner from the person on whom the order is made.

"Expenses incurred by any rural authority in the execution of this section, and not recovered by them as aforesaid, shall be special expenses" (38 & 39 Vic. c. 55, s. 70).

It is an established fact that wells within a town must always be regarded with some suspicion, and where they exist either publicly or privately the local authority would do well to have the water from them analysed with a view to having them closed. Even cisterns, if not frequently examined and cleansed, will cause the water that is stored in them to become polluted, not only from the dust of the air settling in them and the natural impurities of the water passing through them, but frequently from foreign objects falling into them and decaying, such as rats, mice, cats, and in one case that I know of, a sirloin of beef, and in another a plumber! These remained in the cistern until the colour, smell, and taste of the water drew the attention of the drinkers to "something being the matter!" The cure for the chance of such cases as these is of course the constant supply.

CHAPTER XXVI.

HOUSE DRAINAGE.

IT would not be possible in one chapter of a book of this description to enter into all the details and necessary apparatus in connection with house drainage. I propose only to point out some of the town surveyor's duties in connection with this subject, and to add a few remarks which may be of some service.

The definition of the word "drain" as given in the Public Health Act 1875, is as follows:

"'Drain' means any drain of and used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage; or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed" (38 & 39 Vic. c. 55, s. 4).

Although this definition is very clear, it occasionally happens, especially in old towns, that some doubt arises as to whether an existing conduit for sewage is a "drain" or a "sewer,"* for though a conduit is of small size it may be found to be carrying the sewage of two or more buildings, and thus is really "a sewer belonging to the local authority."

This difficulty often leads to litigation where a notice having been served upon an owner of property to put in a new drain in place of one that has been found on examination to be defective, the new work is of course commenced at the junction with the main sewer, and it is not until the new so-called drain is nearly completed that it is found to be "used

* For definitions of the word "sewer," see the chapter on Sewerage.

for the drainage" of more than one building, and is in fact "a sewer into which the drainage of two or more buildings or premises, occupied by different persons is conveyed" (see clause quoted above), and is therefore repairable by the local authority (38 & 39 Vic. c. 55, s. 13).

This legal definition of a drain is somewhat contradicted in the Public Health Acts Amendment Act 1890, section 19 being as follows:

"(1.) Where two or more houses belonging to different owners are connected with a public sewer by a single private drain, an application may be made under section 41 of the Public Health Act 1875 (relating to complaints as to nuisances from drains), and the local authority may recover any expenses incurred by them in executing any works under the powers conferred on them by that section from the owners of the houses in such shares and proportions as shall be settled by their surveyor or (in case of dispute) by a court of summary jurisdiction.

"(2.) Such expenses may be recovered summarily, or may be declared by the urban authority to be private improvement expenses under the Public Health Acts, and may be recovered accordingly.

"(3.) For the purposes of this section the expression 'drain' includes a drain used for the drainage of more than one building." (53 & 54 Vic. c. 59, s. 19.)

Where the town surveyor is in any doubt as to whether the conduit is a drain or a sewer, he should test from whence the sewage comes by passing diluted white lime or carbolic acid down the adjacent water-closets and watching whether it flows through the conduit or not; but even here he is often at fault if the drains are old and dilapidated, as these materials sometimes fail to reach the point he is watching, and he is thus misled.

In connection with the question of house drainage the town surveyor has the following duties to perform:

(1.) To inspect all new drains that are constructed in connection with existing buildings within his district.

(2.) To inspect all new drains of new buildings that are constructed within his district.

(3.) To inspect all defective drains within his district, serve the necessary notices in respect thereof, and inspect the works he has required to be executed whilst they are in progress.

With reference to the first of these duties the following is the clause of the Public Health Act, 1875, which bears upon the point:

"The owner or occupier of any premises within the district of a local authority shall be entitled to cause his drains to empty into the sewers of that authority on condition of his giving such notice as may be required by that authority of his intention so to do, and of complying with the regulations of that authority in respect of the mode in which the communications between such drains and sewers are to be made, and subject to the control of any person who may be appointed by that authority to superintend the making of such communications. Any person causing a drain to empty into a sewer of a local authority without complying with the provisions of this section shall be liable to a penalty not exceeding twenty pounds, and the local authority may close any communication between a drain and sewer made in contravention of this section . . . ." (38 & 39 Vic. c. 55, s. 21).

The first thing therefore that a local authority has to do is to frame the necessary regulations and appoint a "person to superintend the making of such communications."

The following is given as a specimen form of the manner in which these regulations may be compiled: *

* The New York Board of Health require that earthenware drain pipes connecting dwellings with street sewers shall be hard and salt glazed, sound and cylindrical; at least $\frac{5}{8}$ths of an inch thick if 5 inches in diameter, and $\frac{3}{4}$ of an inch thick if 6 inches in diameter. Pipe must be connected with hydraulic cement of

Regulations made and ordained by the Urban Sanitary Authority for , as to the giving of notice before any drains are made to communicate with the sewers of the said Urban Sanitary Authority; regulating the mode in which such communications are to be made: and appointing the person under whose superintendence and control the work is to be executed.

"1.—No communication shall be made with any sewer belonging to the said Urban Sanitary Authority, nor any drain made to empty therein, unless notice of an intention so to do, signed by the owner or occupier of the premises to which such drains belong, be left at the office of the borough surveyor two days previously; and such notice must specify the point at which it is desired that communication shall be made, and the time at which it is proposed the work shall be commenced, and any person not complying with these regulations will be liable to a penalty not exceeding twenty pounds.

2.—Work required to be done in connecting any house drain or drains with the main or public sewer, shall be executed in the following manner:

The ground to be excavated to the required depth with all possible expedition, the work to proceed by night and day; and there shall be maintained during the progress of the work all such fencings, hoardings, struttings, and shorings, as may be necessary for or in consequence of any of the works, for

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the best quality. No "tempered up" cement can be used. The pipes must be laid with such good alignment that the inspector can see through the entire line from the house to the sewer, and every section must be bedded in cement so as to have a firm bearing, not only at the hub, but along its entire length. The inside of the drain must be freed from all cement which may have oozed through at the joints, and from all other obstructions. Before the drain is covered notice must be sent to the Health Department, by the owner or plumber, that the inspector may visit and examine the work, and the Board of Health will not approve or permit a drain which has not been examined by one of its inspectors and found to be properly constructed.

the protection of the public, and of all buildings and property whatever, near to or liable to be affected by the work, which shall also be well watched and lighted.

The shoring and strutting of the excavation is to be done in such manner, with poling boards, waling pieces and struts, as the surveyor shall consider necessary.

All surplus earth or material is to be carted away as speedily as possible. Care must be taken where the excavation is made in a road or path to keep separate the surface material from the lower, so as to replace them in their proper positions.

The excavation shall in all cases where practicable be in open cutting, and not by shafts and headings.

The junction with the main sewer to be done in the following manner:—

The drain shall in no case be less than four inches internal diameter, and shall be constructed of well-burnt glazed socketed stoneware pipes, circular, perfectly true in bore, and straight, with whole socket joints free from flaws, blisters, cracks, or other defects, set in Portland cement joints with a uniform fall, well bedded on well-rammed and solid ground, the sockets being sunk into it so as to give an even bearing. No shafts or sudden falls will be allowed.

Where the junction is with a sewer constructed of pipes, one length of the sewer (or more if necessary) shall be removed and an oblique proper glazed socket junction pipe, set in Portland cement, inserted in its place.

The junction with the sewer shall be of the same size as the drain.

Where the junction is with a brick or stone sewer, the connection shall be made at such height above the invert as the surveyor shall determine, and be made with a glazed socket pipe obliquely in line of current of main sewer, properly bedded in with cement, cut off so as to take the form of the main sewer and offer no obstruction to the proper flow of

sewage therein, or with a properly constructed stoneware block junction.

On completion of the junction, which shall be made before any of the pipe drain is laid, it shall be inspected by the surveyor, and the work must not be further proceeded with until such inspection has been made and the junction pronounced satisfactory. The drain shall be properly trapped between the sewer and the house, with a syphon of such form as the surveyor shall direct, and be at its inlet end or other extremity carried up open its full diameter to above the roof line.

The excavation is to be filled in within six inches of the surface of the ground, with layers of earth not more than six inches in thickness, carefully rammed or punned with iron punners of not less weight than 10 lbs.

The surface of a roadway must be brought up to its proper level with the surface material kept separate, and properly broken or other approved road metal, and the roadway where broken shall be kept in repair by the person opening the ground for a period of twelve months after the completion of the work.

If the excavation is made under a footpath or paved road, the paving must be made good and kept in repair for a similar period.

3.—A. B. C., the present borough surveyor, and his successors in office, or the person for the time being acting as or discharging the duties of borough surveyor, are hereby appointed as the person or persons to superintend the making of such communications with the public sewers as aforesaid."

Notwithstanding the stringency of the above regulations it is very difficult to insure that the whole of the new drain is properly executed by the person who is carrying out the work, for if he wishes to deceive the surveyor's department it is not very difficult to do so in works of this description. It would be far better if all drains of dwelling houses could be

constructed solely by the staff of the local authority, and failing any general Act upon the subject, that they should be able to obtain private powers to do so.

It is illegal for anyone to touch the surface of either roadway or footpath for any purpose whatever* without the consent of the urban authority (38 & 39 Vic. c. 55, s. 149), and especially to touch or interfere with the main sewers. All such work could be done better and cheaper, both for the ratepayers and the owners of property, if carried out by the trained staff of the local authority; nothing would be gained by scamping the work, and one of the worst stumbling-blocks in the interests of sanitation would be removed by this simple and effective measure. Gas and water companies invariably refuse to allow anyone to interfere with their mains or services, but execute the work with their own men; how much more important is it that house drains and sewers should be equally protected. If a gas or water main or house service leaks through defective work it is quickly detected and remedied; not so with a drain or sewer, the deadly gases may be oozing through defective joints, or the foul liquid may be poisoning the soil under the adjacent dwelling houses, and many victims may suffer before the cause is ascertained, and even then laborious legal machinery has to be put in force before it can be rectified.

The only objections that can be raised to the plan I so strongly advocate are, first, the interference with the trade connections and interests of builders and others; and secondly, the responsibility incurred by the local authority to execute thoroughly sound and good work, and the difficulty they might afterwards experience if it was necessary to find fault with their own work. The first objection should really have no weight when lives are at stake, and the responsibility incurred by the second objection ought not to be shirked.

Until some alteration is made in the present law the town

* See chapter on "Breaking up Streets."

surveyor must be as vigilant as he can, and endeavour to induce the public to look more closely themselves into such all-important points.

With reference to this question and as a very imperfect attempt to induce persons to allow the Local Authority to execute the necessary work themselves in connection with house drainage the following clause has been inserted in the Public Health Acts Amendment Act 1890.

"(1.) Where the owner or occupier of any premises is entitled to cause any sewer or drain from those premises to communicate with any sewer of the local authority, the local authority shall, if requested to do so by such owner or occupier, and upon the cost thereof being paid in advance to the local authority, themselves make the communication and execute all works necessary for that purpose.

"(2.) The cost of making such communication (including all costs incidental thereto) shall be estimated by the surveyor of the local authority, but in case the owner or occupier of the premises, as the case may be, is dissatisfied with such estimate he may, if the estimate is under fifty pounds, apply to a court of summary jurisdiction to fix the amount to be paid for such cost, and if the estimate is over fifty pounds have the same determined by arbitration in manner provided by the Public Health Acts.

"(3.) A local authority may agree with the owner of any premises that any sewer or drain which such owner is required, or desires, to make, alter, or enlarge, or any part of such sewer or drain shall be made, altered, or enlarged by the local authority." (53 & 54 Vic. c. 59, s. 18.)

The next duty of the town surveyor is to inspect all drains of new buildings that are being constructed in his district.

I have dealt with this subject in the chapter on "New Buildings." The model bye-laws to which I have there referred contain some excellent principles in reference to this

matter, and too much power cannot be given to a local authority in respect of house drains, even to the extent of prohibiting any one else to construct them. The main sewer, shared in common as it is by all the inhabitants of a town, must be looked upon as a common danger, and each house that connects with it should so far as possible be severed from it; at the same time the drain must be so constructed that the sewage reaches the sewer as quickly and as completely as possible, without any nuisance or knowledge of the unpleasant nature of its contents or those in the sewer reaching the inhabitants of the house: this is the key-note of all house drainage, and many excellent books and descriptions of this class of work have been from time to time written.

The next duty of the town surveyor is to inspect all defective drains within his district, and serve the necessary notices, &c.

This duty is embodied in the following clauses of the Public Health Act 1875:

"Where any house within the district of a local authority is without a drain sufficient for effectual drainage, the local authority shall by written notice require the owner or occupier of such house, within a reasonable time therein specified, to make a covered drain or drains emptying into any sewer which the local authority are entitled to use, and which is not more than one hundred feet from the site of such house; but if no such means of drainage are within that distance, then emptying into such covered cesspool or other place not being under any house as the local authority direct; and the local authority may require any such drain or drains to be of such materials and size, and to be laid at such level and with such fall, as on the report of their surveyor may appear to them to be necessary.

"If such notice is not complied with, the local authority may, after the expiration of the time specified in the notice, do the work required, and may recover in a summary manner

the expenses incurred by them in so doing from the owner, or may by order declare the same to be private improvement expenses.

"Provided that where, in the opinion of the local authority, greater expense would be incurred in causing the drains of two or more houses to empty into an existing sewer pursuant to this section, than in constructing a new sewer and causing such drains to empty therein, the local authority may construct such new sewer, and require the owners or occupiers of such houses to cause their drains to empty therein, and may apportion as they deem just the expenses of the construction of such sewer among the owners of the several houses, and recover in a summary manner the sums apportioned from such owners, or may by order declare the same to be private improvement expenses" (38 & 39 Vic. c. 55. s. 23).

The above clause is most simple under which this duty can be carried out, provided it can be proved that the house * is "without a drain sufficient for effectual drainage;" and for this purpose it would probably be necessary to enter the premises and open up and examine the drain, unless, of course, it was a case where no drain existed to the house at all, or was evidently and notoriously without "effectual drainage." In order to enter for this purpose the requisite powers are conferred in the following clause of the Public Health Act 1875:

"The local authority, or any of their officers, shall be admitted into any premises for the purpose of examining as to the existence of any nuisance thereon, or of enforcing the provisions of any Act in force within the district requiring fireplaces and furnaces to consume their own smoke, at any time between the hours of nine in the forenoon and six in the afternoon; or in the case of a nuisance arising in respect

* The definition of house is as follows:—"House" includes schools, also factories and other buildings in which more than twenty persons are employed at one time. (38 & 39 Vic. c. 55, s. 4.)

of any business, then at any hour when such business is in progress or is usually carried on.

"Where under this Act a nuisance has been ascertained to exist, or an order of abatement or prohibition has been made, the local authority or any of their officers shall be admitted from time to time into the premises between the hours aforesaid, until the nuisance is abated, or the works ordered to be done are completed, as the case may be.

"Where an order of abatement or prohibition has not been complied with, or has been infringed, the local authority, or any of their officers, shall be admitted from time to time at all reasonable hours, or at all hours during which business is in progress or is usually carried on, into the premises where the nuisance exists, in order to abate the same.

"If admission to premises for any of the purposes of this section is refused, any justice on complaint thereof on oath by any officer of the local authority (made after reasonable notice in writing of the intention to make the same has been given to the person having custody of the premises), may, by order under his hand, require the person having custody of the premises to admit the local authority, or their officer, into the premises during the hours aforesaid; and if no person having custody of the premises can be found, the justice shall, on oath made before him of that fact, by order under his hand authorise the local authority or any of their officers to enter such premises during the hours aforesaid.

"Any order made by a justice for admission of the local authority or any of their officers on premises shall continue in force until the nuisance has been abated, or the work for which the entry was necessary has been done" (38 & 39 Vic. c. 55, s. 102).

The above clause also gives the necessary powers of entry where the following clause of the Public Health Act is enforced with reference to defective house drainage, instead of the 23rd section which I have quoted.

"On the written application of any person to a local authority, stating that any drain, watercloset, earthcloset, privy, ashpit, or cesspool on or belonging to any premises within their district is a nuisance, or injurious to health (but not otherwise), the local authority may, by writing, empower their surveyor or inspector of nuisances, after twenty-four hours' written notice to the occupier of such premises, or in case of emergency without notice, to enter such premises, with or without assistants, and cause the ground to be opened, and examine such drain, watercloset, earthcloset, privy, ashpit, or cesspool. If the drain, watercloset, earthcloset, privy, ashpit, or cesspool on examination is found to be in proper condition, he shall cause the ground to be closed, and any damage done to be made good as soon as can be, and the expenses of the works shall be defrayed by the local authority. If the drain, watercloset, earthcloset, privy, ashpit, or cesspool on examination appear to be in a bad condition, or to require alteration or amendment, the local authority shall forthwith cause notice in writing to be given to the owner or occupier of the premises requiring him forthwith, or within a reasonable time therein specified, to do the necessary works; and if such notice is not complied with, the person to whom it is given shall be liable to a penalty not exceeding ten shillings for every day during which he continues to make default, and the local authority may, if they think fit, execute such works, and may recover in a summary manner from the owner the expenses incurred by them in so doing, or may by order declare the same to be private improvement expenses" (38 & 39 Vic. c. 55, s. 41).

In acting upon the above clause it is well to note the machinery that is necessary in order to secure success in the event of a prosecution.

(1.) The notice to the local authority of the existence of a nuisance arising from a drain, &c., must be in writing, and that authority must then proceed to consider the notice.

(2.) If they agree to take action the local authority may empower their surveyor to enter the premises (with or without notice as the case may require) but this order to him must also be in writing.*

(3.) If the surveyor is allowed by the occupier of the premises to enter (and in default he must put the 102nd section which I have quoted in force) he may then open the ground "with or without assistants."

(4.) If he finds a defective drain he must then report to the local authority in writing, unless he has been primarily invested by the local authority with such powers as will dispense with such report.†

(5.) The local authority shall "forthwith cause notice in writing to be given to the owner, &c.," to do the work.

(6.) If the owner executes the work the surveyor must supervise its execution.

(7.) If this work is not done within a reasonable time, the local authority "may if they think fit" execute the works; the surveyor has probably to carry them out, after having obtained the necessary permission to enter for the purpose.

(8.) The costs of the work have to be recovered.

Anyone acquainted with local government will know how

* Notices, orders, and other such documents under this Act may be in writing or print, or partly in writing and partly in print; and if the same require authentication by the local authority, the signature thereof by the clerk to the local authority or their surveyor or inspector of nuisances shall be sufficient authentication (38 & 39 Vic. c. 55, s. 266).

† Having obtained admission to the premises, the inspection of the alleged nuisance should be so conducted as to enable the local authority to determine whether it exists, or whether it existed at the time the notice was given, and whether, although it has since been removed or discontinued, it is likely to recur or to be repeated; and in all cases it will be the most expedient course to reduce to writing the result of the inspection. When the inspection is made by an officer of the local authority, it will also be expedient for that authority, on receiving the report of their officer formally and in writing, to record the conclusions to which they have come after considering his report in order to ground further proceedings. (*Vide* 'Law of Public Health and Local Government,' by W. C. and A. G. Glenn, 8th edition, p. 81.)

difficult and tedious such processes must necessarily be, the delay between the meetings of the local authority being quite sufficient to make the matter in dispute last a considerable time, and this delay is extremely undesirable where a nuisance arising from a defective house-drain is in existence.

There seems to be no doubt that the clauses which are given in the Public Health Act 1875 empower the local authority to specify without dispute the class of work they think necessary in order to remedy any evils arising from a defective drain; but it is a pity that some more simple process cannot be introduced to improve the sanitary condition of a house without the necessity of so much laborious legal machinery.

There is still one other clause in the Public Health Act 1875, which refers to house drainage, and it is as follows:

"Every local authority shall provide that all drains, water-closets, earthclosets, privies, ashpits, and cesspools within their district be constructed and kept so as not to be a nuisance, or injurious to health" (38 & 39 Vic. c. 55, s. 40). But this clause is usually taken to apply rather to nuisances arising from temporary defects than to more important structural defects in a drain, and such nuisances come more under the cognizance and duties of the inspector of nuisances than those of the town surveyor.

It would not be possible, as I have already stated, in one chapter to give all the detail descriptions of house drains and the necessary apparatus in connection therewith, and besides very many excellent books, pamphlets and papers have been from time to time written on this important subject.* Before,

* For ample information on the subject of house drainage and similar subjects see the following books, etc. :—Bailey Denton's 'Sanitary Engineering'; Baldwin Latham's 'Sanitary Engineering'; Buchan's 'Plumbing'; Slagg's 'Sanitary Work'; Hart's 'Manual of Public Health'; Hellyer's 'Plumber and Sanitary Houses'; Galton's 'Healthy Dwellings'; 'House Drainage,' by W. A. Tylor; Philbrick's 'American Sanitary Engineering,' and many others, besides the nume-

however, bringing this chapter to a conclusion, I will give a list of the essential requirements of all good house drainage, which may be of some use to the town surveyor:

(1.) A house drain should be constructed of stoneware pipes (not earthenware or fire clay), salt glazed, perfectly smooth inside, of true circular section and thickness of material, straight in the direction of their length, with whole sockets of proper depth, and free from any cracks, blisters, sand holes, or other defects. As even the most carefully manufactured pipes vary somewhat in diameter of sockets, &c., it is well to have them sorted before commencing the work; it is scarcely necessary to add that no "seconds" should be allowed on the works.

(2.) The internal diameter of the drain should not be too large; 6 inches is generally quite sufficient to carry off all the sewage from an extensive establishment, even if the water from the roofs or a portion of them is included.

(3.) The inclination is governed by circumstances, but about 1 in 60 is found to be a very convenient fall for many hydraulic, and other reasons, and will keep a syphon clear.*

(4.) The jointing of the pipes should be executed with great care; if cement joints are made each pipe should be jointed separately, and it should be seen that no cement is left in the drain, and that the joint is good all round. Sometimes tarred gaskin is used to prevent the entrance of cement into the pipes, and Hassall's patent joints are excellent where running water or sewage has to be contended with, or where good work is required.†

(5.) The sockets of the pipes should be sunk into the ground at the bottom of the trench so as to give an even

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rous reports of the "Health of Towns Commission," and several articles in the *Sanitary Record*, the *Sanitary Engineer of New York*, and Mr. Rawlinson's 'Hints,' all of which should be studied by the town surveyor.

* If sufficient fall cannot be obtained, provision for automatic flushing should be made.

† For description of these pipes see chapter on Sewerage.

bearing, which amongst other benefits dispenses with the chance of settlements.

(6.) No pipes should be allowed to be covered in until they have been inspected by the town surveyor or his assistants, and in order to test the soundness of the joints, fill the drain with water, having first stopped up the lower end, and note if the level of water is maintained.*

(7.) Drains should not pass under buildings if it can be avoided, but if unavoidable they must be buried in good concrete, and relieving arches turned to any walls passing over them. In America iron pipes are used under houses with great advantage.

(8.) Care must be exercised, in filling in over pipes, not to break or injure them.

(9.) The trap to a house drain should be a syphon with a good cascade action, its position must be guided by circumstances.

(10.) The drain should end at the outside wall of the house and be carried up the wall its full diameter to above the roof for ventilation, an inlet for fresh air being essential on the house side of the trap; if the drain has to pass under the house it must be similarly carried up on the other side.

(11.) The connection with the main sewer has been already described.

(12.) All waste pipes and overflows to be entirely cut off from connection with any drain, and empty on to special gullies outside the house.

The objects of good drainage may be summarised as follows: To ensure that there shall be no escape of either liquid or gas from any portion of the drain or soil pipes, that the house is isolated from its neighbour and the main sewer,

* The methods usually adopted for testing drain and soil pipes are:—

(1.) The smoke test, relying upon sight and smell.

(2.) The Peppermint, paraffin or similar *smell* test.

(3.) The water test, which can only be applied to the drains and not vertical soil pipes.

that a current of fresh air is constantly passing through all the drains and soil pipes.

In conclusion I would urge the necessity of a register of all drains being kept that are examined by the surveyor's department. This can be done by having a series of numbered note-books kept solely for this purpose, and all the information thus acquired should also be plotted on the map of the town if on a sufficiently large scale.

The necessity of correct plans of the drainage of buildings cannot be over-estimated, especially for hospitals, asylums, workhouses, schools, or other public buildings, and even for the smallest dwelling house such a plan would often prove to be the greatest boon to the occupier or owner, as well as at all times to the town surveyor, the medical officer of health, and the inspector of nuisances.

CHAPTER XXVII.

PUBLIC PLEASURE GROUNDS AND STREET TREES.

AMONGST the clauses of the Public Health Act 1875, which affect the duties of the town surveyor will be found the following:

"Any urban authority may purchase or take on lease, lay out, plant, improve, and maintain lands for the purpose of being used as public walks or pleasure grounds, and may support or contribute to the support of public walks or pleasure grounds provided by any person whomsoever." *

"Any urban authority may make byelaws for the regulation of any such public walk or pleasure ground, and may by such byelaws provide for the removal from such public walk or pleasure ground of any person infringing any such byelaw by any officer of the urban authority or constable" (38 & 39 Vic. c. 55, s. 164).†

There are very few, if any, cities or towns in this country that have not availed themselves of this clause, even if they did not already possess one if not more public parks or pleasure grounds of some description, these having either been given by some benevolent citizen or acquired in some other manner by the urban authority.‡

Included in the powers given by the above clause were no doubt those regulating the acquisition and support of

* See also 53 & 54 Vic. c. 59, s. 45, and also 53 & 54 Vic. c. 15.

† By the Public Health Acts Amendment Act 1890, powers are given to Urban Authorities to close public parks, etc., and let them for shows etc., under certain restrictions; the clause also gives other powers in connection with public pleasure grounds. (53 & 54 Vic. c. 59, s. 44.)

‡ By the "Commons Act 1876," powers were given to acquire and lay out commons for purposes of public recreation, etc.

recreation or public playgrounds, public walks, or old city walls or other places, and disused burying grounds,* but recent legislation has extended the provisions of the Metropolitan Open Spaces Acts 1877 and 1881 to sanitary districts in England, Wales, and Ireland, by which considerable powers are given to local authorities over disused burial grounds, &c., under the Open Spaces Act 1887 (50 & 51 Vic. c. 32).†

In connection with the above clause of the Public Health Act, the town surveyor may have the following duties to perform:

To advise his corporation upon the value, suitability, and desirability of any site that is intended for use as a public park or recreation ground, and after its acquisition to adapt it for the requisite purposes. To effect this it must be drained and laid out with carriage-drives, walks, lawns, flower-beds, plantations, and sometimes streams, waterfalls, and lakes. He must design and erect the necessary lodges, entrance gates, fences, shelters, seats,‡ band-stands, and fountains, and must afterwards superintend the maintenance of these and the rest of the works in connection with the pleasure ground.

It would be impossible to lay down any rules for the guidance of a surveyor in carrying out these works, for each case must be dealt with as its exigencies require, and a great deal ot common sense, as well as engineering, architectural, and artistic skill must be displayed by him in carrying out any works of this description, details of which could not possibly be given in a book of this size dealing with so many subjects.§

* Upon this latter point *Vide* 24 & 25 Vic. c. 61, s. 21.

† See also 47 & 48 Vic. c. 72.

‡ As a preservative against the malicious disfigurement of wooden seats, I have seen the following inscription placed upon some seats in an old public park, "Never cut a friend," and it had apparently the desired effect.

§ As an instance of the size and importance works of this description may assume, the Bois de Boulogne, Paris, is an example. It covers an area of 2000 acres, of which one half is forest, one quarter is grass, one-eighth roads, and

A few suggestions may, however, be of some service on these points.

Public playgrounds for children should be composed of large, level, well-rolled, gravelled spaces, with a few trees for shade, and some sheds for shelter. Turf soon gets spoiled and worn bare, when it is not so pleasant as well-rolled gravel, as it is far more dusty in dry weather and very damp in wet, besides having an uncared-for appearance.

In public parks, shrubs planted singly directly on the lawns without any beds around them have a very pleasing look, although it adds somewhat to the difficulty of mowing the grass. The grass itself is greatly improved if it is well dressed with manure in the spring and constantly watered all the year round.

Paths should be gravelled in the autumn, care being taken to wait until all the leaves have fallen, which are swept up and removed at once. A good fence for a path, if any protection is necessary, is either a strained wire fence or cast-iron hoops representing bent sticks. They are both cheap, and stand well against weather and rough treatment.

A very economical and neat border to the footpaths can be made from the old used-up flagstones from the foot pavements of the streets; these cut up and placed on edge, especially if in conjunction with a pitched channel gutter of pebbles, look remarkably well.

Ornamental flints make a pretty border, but they are nasty things for a child to fall upon.

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about 70 acres is water. One of the most beautifully arranged artificial public parks in this country is Sefton Park, Liverpool, where the most perfect arrangements of lawns, plantations, lakes and drives, have been carried out. The Forest of Saint Germain, which is a public park, is 8000 acres in extent, the Bois de Vincennes 2500 acres, Saint Cloud 1000 acres, the Forest of Fontainebleau covers 42,000 acres. The principal parks of Vienna are the Prater, 1500 acres; the Glacis, about 500 acres; the Volksgarten and the Hofgarten. Berlin boasts chiefly of the Thiergarten, 650 acres. There are large parks in the suburbs of Potsdam. Amsterdam's chief pleasure ground is Vondel Park, which comprises 150 acres. The largest park of Brussels is the Bois de Cambre, of 300 acres; next in size are the Parc de Bruxelles, 30; and the Parc Leopold, 25 acres.

For flower-beds a flat border or edge of ivy has a very telling effect. If there are ponds or lakes in the park there should be a broad path or road close to the water's edge. It is surprising what a great advantage in effect this has over the plan of leaving a strip of green between the path and the water.

The selection of the proper shrubs for a park and their distribution is a matter that requires the advice of an expert gardener. The following list of ordinary shrubs that will thrive well almost anywhere in this country may however be of use for reference:

Aucubas.	Lilacs.
Azaleas.	Mahorrias.
Box.*	Pampas grass.
Berberises.*	Privet.*
Euonymus.*	Rhododendrons.
Hollies.*	Thorns.
Ivies.	Yuccas.
Laurels.	

With regard to the selection of trees, this also requires skilled advice; but a list is given further on in this chapter, of trees suitable for street planting, which may be also some guide in this respect.

In high gales of wind the surveyor may be expected to endeavour to save valuable trees in a public park from being blown down. This may sometimes be effected by a judicious application of chains or ropes, but the better plan is to keep all trees well pruned and as free as possible from "top hamper" and undue leverage from overhanging limbs.

On the pruning of trees and the removal of large limbs I must refer my readers to a most admirable little book recently published in America, being a translation from the celebrated 'Treatise on Pruning Forest and Ornamental Trees, by A. des Cars,' which enters most fully into the subject, and being of great practical value, should be studied

* Those marked with an asterisk will thrive when planted under trees, especially the genus Berberis.

by anyone who has anything to do with the care of forest or other trees.*

The planting of trees along the sides of streets and roads by local authorities seems to be illegal, unless the authority has adopted Part III. of the Public Health Acts Amendment Act 1890, which contains the following section:

"Any urban authority may,† if they see fit, cause trees to be planted in any highway repairable by the inhabitants at large within their district, and may erect guards or fences for the protection of the same, provided that this power shall not be exercised, nor shall any trees so planted be continued so as to hinder the reasonable use of the highway by the public or any person entitled to use the same, or so as to become a nuisance or injurious to any adjacent owner or occupier" (53 & 54 Vict. c. 59, s. 43).

Although for many years past local authorities in this country have in some cities and towns planted a great number of trees at the sides of their streets, our French neighbours are much in advance of us.‡ It is true that in this country, owing to the much larger consumption of coal as a domestic fuel, there is more soot in the air, but it is erroneous to suppose that trees will not thrive well in England. No doubt the moisture of our climate causes the soot or "blacks" to adhere to the leaves and limbs of the trees, but for that reason deciduous and not evergreen trees should be selected for planting in towns, and these, if well chosen and carefully planted, will most undoubtedly fully repay their first cost and maintenance by the additional beauty to the

* 'A Treatise on Pruning Forest and Ornamental Trees,' by A. des Cars, translated from the 7th French edition, with an introduction by Charles S. Sargent, etc. Published by A. Williams and Co., Boston, U.S.A., 1881.

† No power is given, however, to Rural Authorities to plant trees, and such action is consequently illegal.

‡ In Paris in the year 1880, there were 90,000 trees in the streets, besides 20,000 more in the cemeteries. (*Vide* Report of Mr. Till, the Borough Surveyor of Birmingham, 20th December, 1880.) There are also upwards of 8000 seats in public places; the trees and seats costing nearly 100,000*l.* per annum to maintain.

street, the agreeable shade they cast, and their generally healthful action on the population.

In selecting trees to plant along the sides of the streets or roads in any towns, it is well to bear in mind that the following qualities are necessary:—

The tree must be hardy; it must not be affected by a long-continued drought; heat must not wither it nor make it look rusty; it must be able to withstand dust, smoke, soot, foul air, and the insidious attacks of insects, and be able to recover from any malicious or accidental injury it may receive.

The tree must be of rapid growth, and develop a straight, clean stem with shady foliage. It must be graceful either in full leaf or when bare as in winter; its roots must not require too much room, and they must be able to withstand the effects of pollution or rough treatment.

Although the foregoing list of requirements may seem rather formidable, yet amongst the trees whose names now follow there will be found some which meet many, if not all of these requirements, and which, if properly planted with all reasonable care, may be expected to thrive if planted at the sides of the streets in any town in this country.

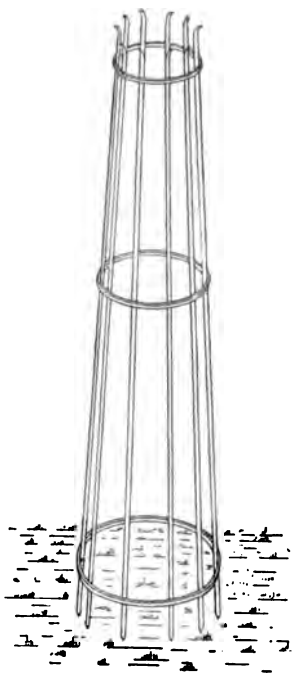
List of Trees suitable for Planting at the Sides of Streets.

Western Plane.	Sycamore.
Lime.	Copper Beech.
Maple.	Pawlonia.
Horse Chestnut.	Oilantus Glandulosa.
Elm.	Laburnum.
Tulip tree.	Lilac.
Lombardy Poplar.	Almond.
Ash.	Peach.
Willow.	Hawthorne.
Beech.	Acacia.
Birch.	Double Cherry, etc.
Oak.	

Of the above list the western plane for many reasons is the most desirable. Its freshness when it bursts into

The tree should also be protected with a slight iron grill or railing to prevent mischievous persons from cutting their names on the trunk, climbing up into the tree, or breaking off its branches whilst still young. The following sketch shows the description of grill necessary, which is light, cheap, and at the same time effective.

The following interesting particulars of the manner in



which street planting of trees is conducted in Paris will be useful, and are given *in extenso*: *

"When the boulevarde is marked out and levelled, if the soil is of bad quality, as is nearly always the case, trenches are dug in the footway from one end of the boulevarde to the other. The width of this trench is usually about 6 feet, and

* *Vide* 'The Parks, Promenades, and Gardens of Paris,' by W. Robinson, F.L.S., 1869, p. 128.

its depth 4 or 5; and before filling it in, drain-pipes are laid along the sides, made with lapped joints so that the roots shall not enter between them. The trench is then filled with good garden earth, raising it a little higher than the level so as to allow for settling. In this ground the trees are planted about 6 yards apart. They should be carefully chosen with perfect roots, and moderately pruned. Formerly the stem was cut at about 9 feet from the ground, but this had the bad effect of preventing the top of the tree from being straight, and the practice has been given up. The trees are next staked and tied with wire over a neat wad of straw, which prevents all injury to the stem. A protecting cage, neither heavy nor very expensive, is placed round the tree to prevent accidents; and if the weather be at all dry at the time of planting, the trees are copiously watered."

The cost of planting a tree in the Paris boulevard is thus given: *

	fr. c.
15 cubic metres of excavation at 4 francs	=60·00
15 cubic metres of vegetable mould at 4 francs ..	=60·00
Training poles about 5 metres in height	= 1·50
	121·50
Average deduction of 15 per cent. resulting from letting by tender	18·23
Price by contract	103·27
Pipe drainage and materials	11·15
Watering appliance (average)	2·50
Cast iron grating round the base	46·69
Transport of tree from nursery	2·00
Planting, including stakes	3·00
Iron basket (to protect stem)	8·70
The tree	5·00
Labour for planting	1·69
	184·00

The maintenance of each tree costs 1·58 francs.

The total cost, therefore, of each tree capitalised reaches about 8*l.*, and its life is said not to exceed twelve years

* *Vide* 'L'Architecte,' 20th November, 1880, p. 370.

Before closing this chapter it is well to advert to the evident importance that the legislature attach to the preservation of trees along the sides of the public streets in this country and their desire to protect them, as the following clause of the Public Health Act 1875 will show. ". . . Any person who, without the consent of the urban authority, wilfully displaces or takes up, or who injures the pavement, stones, materials, fences, or posts of, *or the trees* in, any such street shall be liable to a penalty not exceeding five pounds, and to a further penalty not exceeding five shillings for every square foot of pavement, stones, or other materials so displaced, taken up, or injured; he shall also be liable in the case of *any injury to trees* to pay to the local authority such amount of compensation as the court may award" (38 & 39 Vic. c. 55, s. 149).*

It is a great source of regret that mischievous persons can be found who by their wilful malice injure the trees which have been planted at the sides of streets out of the public funds and with great expense and trouble.

* It is rather curious to note that this legal protection was given to trees illegally planted, as this clause of the Public Health Act was in force fifteen years before it was found out that the Urban Authority had no legal power to plant the trees!

CHAPTER XXVIII.

PUBLIC ABATTOIRS.

THE following is the clause of the Public Health Act 1875 which empowers an urban authority to establish public slaughter-houses (or "abattoirs"* as they are sometimes called) for the purposes of the district they govern :

Any urban authority may, if they think fit, provide slaughter-houses, and they shall make byelaws with respect to the management and charges for the use of any slaughter-houses so provided.

"For the purpose of enabling any urban authority to regulate slaughter-houses within their district, the provisions of the Towns Improvement Clauses Act 1847, with respect to slaughter-houses, shall be incorporated with this Act.†

"Nothing in this section shall prejudice or affect any rights, powers, or privileges of any persons incorporated by any local Act passed before the passing of the Public Health Act 1848, for the purpose of making and maintaining slaughter-houses" (38 & 39 Vic. c. 55, s. 169).

The great necessity for the establishment of one or more public slaughter-houses in any town can only fully be realised by persons who will take the trouble to inspect those which are private; they are generally placed near the shops of the butchers for the sake of convenience, the result being that they are situated in the central portions of the town and are thus surrounded by closely packed dwellings. The

* The word "abattoir" is a French word from "abattre" to fell; it is used in this country to designate a group of slaughter-houses.

† The clauses referred to are contained in 10 & 11 Vic. c. 34, and ss. 125, 226, et seq.; they refer to the registration, licensing and management of private slaughter-houses, and need not be commented upon here.

private slaughter house often consists of a stable or shed which has been converted into an ill-designed slaughter-house, badly paved, with imperfect drainage; they are frequently not sufficiently lighted, ventilated or drained, and are utterly unfitted for the purposes for which they are used.

Their position also is often so badly chosen that the children in the vicinity resort there to see the animals killed, and the poor beasts have in some cases to be driven through a narrow passage into the slaughter-house itself, where trembling at the sight and smell of the blood and carcases of its dead companions, it remains tethered until its turn comes to fall a victim to the blow of the slaughter-man: a blow which sometimes has often to be repeated before its object is attained, owing to the bad light and cramped surroundings of the place.

As these slaughter-houses are generally rented by the butcher using them at large rentals (such accommodation being scarce), it is not to be expected that he will spend much money to improve property which is not his own; but notwithstanding the loss of weight incurred by the animal to be slaughtered thus fretting and sweating in its terror, the damage to the meat by its being dressed in the same locality, with the live beasts steaming and smelling in the vicinity, and the exorbitant rents demanded, still there are great objections always raised by butchers in towns to the establishment of public slaughter-houses. These objections are based by them on the following grounds:

They contend that the carriage of the meat from the slaughter-house to their shop deprives them of some of their profits; that slaughtering their animals in the presence of other butchers leads to disparaging remarks and trade jealousies, and that they sometimes are robbed of fat, tools, &c.

These arguments are groundless if the public abattoir is

properly designed, is in a suitable locality, and is well managed.

There are no powers by which butchers can be compelled to abandon private slaughter-houses, and use those provided by the urban authority, so long as the byelaws of the authority are not infringed ; but as the law stands at present, private slaughter-houses may be licensed (10 & 11 Vic. c. 34, ss. 125, 126), or registered (10 & 11 Vic. c. 34 s. 127) and the only manner in which they could be closed (which would then compel the butcher to use the public abattoir) would be by putting the 129th section of the same Act in force, which states that the justices before whom any person is convicted of killing or dressing cattle contrary to the provision of the Act, or of the non-observance of any byelaw or regulation of the local authority, in addition to the penalty may suspend *the licence* for any period not exceeding two months ; or in the case of the owner of any *registered* slaughter-house may forbid for any period not exceeding two months, the slaughtering of cattle therein. For a second or other subsequent like offence, in addition to the penalty the justices may revoke the licence or absolutely forbid the slaughtering of cattle in the particular house or yard. In such an event the local authority may refuse to grant any *licence* whatever to the person whose licence has been revoked, or on account of whose default the slaughtering of cattle in any *registered* slaughter-house has been forbidden.

With reference to the establishment anew of the business of a slaughterer of cattle in London, the following particulars required to be deposited by the applicant with the Metropolitan Board of Works will be useful.

A plan of the premises and sections of the buildings drawn to a scale of ¼ inch to the foot and showing the proposed or existing arrangements for drainage, lighting, ventilation and water supply, with a key plan of the locality, have to be deposited, as well as replies to the following questions :

(1.) State what place for the accommodation or poundage of the cattle about to be slaughtered is provided; if such place has an entrance way for the cattle otherwise than through the slaughter-house; if separated from the slaughter-house by a brick partition with a door; and also what provision is made therein for watering animals.

(2.) State if slaughter-house and its poundage is within 20 feet of an inhabited building; and if it has any entrance opening directly on a public highway.

(3.) State if the entrance to the premises is apart from and independent of any shop or dwelling house; if from a street at the side or rear; and also the height of the entrance gates.

(4.) State the dimensions of the slaughter-house, length, breadth, height to eaves, and construction of the roof; and give similar information about the poundage.

(5.) State if slaughter-house and poundage are drained by glazed pipes communicating with the public sewer, or how; how drains are trapped; and if gratings have openings greater than three-eighths of an inch across.

(6.) State if floors are below level of outside road or footway, and if paved with asphalte, or flag-stones set in cement or how.

(7.) State how walls of slaughter-house are constructed, and if they are covered with hard smooth and impervious material to a height of at least 4 feet; and, if so, state what material is used, and to what height it is carried.

(8.) State how slaughter-house and poundage are lighted if with lantern, sky, or side-lights, or otherwise.

(9.) State how ventilated, if by openings, windows, louvre boards, or otherwise.

(10.) State what provision is made for water-supply, the capacity of the cistern, and at what height it is placed above floor level.

(11.) State if any watercloset, privy, urinal, cesspool, or

stable, is within, or communicates directly with the slaughter-house.

(12.) State if any rooms or lofts are constructed, or proposed to be constructed, over the slaughter-house.

(13.) State if the premises will be provided with all the necessary and most approved apparatus and tackle for the slaughtering of cattle.

Having thus far dealt with private slaughter-houses, I will now return to the question of the provision of public establishments of the kind by the urban authority; for it is usually the duty of the town surveyor to advise his corporation upon such a matter.

First, as to the site of the proposed public abattoir, this depends greatly upon what sites are at the command of the town; it should if possible be near the cattle market to prevent the passage of animals through the streets, not only on account of the great public inconvenience, but also the loss of weight to the animal,* and the heated and bad state into which its blood becomes from the exercise, and the violent blows of the drovers' sticks.

The site should be isolated, and yet not too far from the shops of the butchers, or the cost of carriage of the meat will be considerable; it is almost needless to say that it should be easily and effectively drained, and the more air with which it can be surrounded the better. It is imperative that the entrance for the live beasts should be separate from the exit of the dead meat, and the approach roads to the site should not be narrow.

In laying out the site every town surveyor must use his own judgment; but the following plan on which the site of the excellent public abattoir at Manchester is laid out may serve as some guide for this purpose, although of course this establishment is on a very large scale indeed, and is in

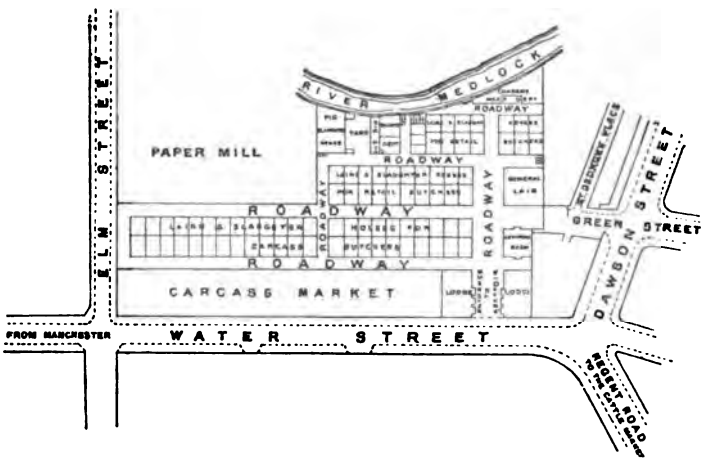
* An ordinary beast is said to lose 3 cwt. in weight in a journey from Edinburgh to London.

connection with a carcass market more than 500 feet in length.

In designing an abattoir on a large scale provision for the following accommodation should be considered.

(1.) *Lairs for cattle and pens for sheep.*

These should be separated from the slaughter-house by a smaller temporary lair in which the beast whose turn has come can be fastened to the halter by which he is dragged into the slaughter-house, the sides of the door-way being lined with iron for this purpose. The paving of the lairs may be of asphalte, but care must be taken that near the door of



PLAN OF MANCHESTER SLAUGHTER-HOUSE.

slaughter-house, the paving is of pitchers or something that is not at all slippery, as here the frightened beast often struggles and draws back when he sees the "engines of destruction" in the slaughter-house, and smells the blood of those who have gone before.

The lairs must be thoroughly well drained, lighted, and ventilated, and troughs for hay and water placed for each beast, for although the animals are not expected to remain long in the lairs before being killed, still it is very important that they should be well and kindly treated, and rest, so

that they may obtain their normal condition before being killed.

A door easily closed should shut off the lair from the slaughter-house, as it is open to question, if animals do not see with fear the hapless fate of their comrades; for this and other obvious reasons the animals must on no account be permitted to pass through the slaughter-house to reach the lair.

The lairs should be well lighted artificially, as a great deal of slaughtering is conducted before and after daylight.

(2.) *The slaughter-houses.*

These may be separate or in one long building used in common by the butchers; both systems have their advantages and disadvantages.

The long building has the advantage of greater economy in erection and of management, as one inspector can see from end to end of it. Where also a large site is not available greater advantage can be taken of a slaughter-house erected on this plan, as several butchers can slaughter in turn; the lairs, however, must be kept separate. The butchers do not like this plan, but prefer privacy, and a great deal of "horse play" is sometimes indulged in by the slaughtermen at work in a large building. The method of payment for the use of a slaughter-house of this description cannot well be by rent, but by head of animal slaughtered, and this is open to the objection of possible fraud. It is necessary also to have separate slaughter-houses for the sheep and the pigs.

Whether the slaughter-houses are constructed separately or in one long building, the detail requirements are much the same.

The pavement of the floor should be placed on concrete and it should be constructed of some material that is easily cleansed, is impervious to moisture, and is not slippery either wet or dry. It must also be of sufficient durability, and be strong enough to bear the weight of the dead-meat carts

which have to back in over it under the beams carrying the carcases, should there be no dead meat market in connection with the slaughter-house as at Manchester, Dundee, &c.

The requirements of such a floor are met by good natural compressed or mastic asphalte. The necessary holes for the reception of the flaying sticks used in many parts of England can be easily managed by inserting either small brass sockets specially made, or more simply by pieces of gas-pipe cut into lengths of about an inch set tight in the asphalte.

The walls of the slaughter-house must be of sufficient strength to carry the beams or girders of the overhead hoisting gear, as well as some tons of hanging carcases, as will presently be explained.

The inside of these walls must be lined to a height of about 6 feet above the floor line with some material which is impervious and easily cleaned. Glazed white tiles or bricks are sometimes used for this purpose, but are apt to get chipped or broken, and I have found that asphalte, although dark in colour, answers the purpose admirably, and is much cheaper.

With regard to the drainage of the slaughter-house, this should, if possible, be so arranged that there are no gratings or gully-pits in the house itself. The floor should fall about 1 in 30 from the lairs to the cart doors, so that everything should pass outside into a gutter in which the necessary gratings and gully-pits can be arranged. If this is thought to be objectionable, pits with double gratings, the lower one being only a plate with perforated holes, can be placed in the slaughter-house so as to prevent any solid matter whatever from entering the drains, and these pits can be united by short drains with gully-pits outside. The double grating should in any case be inserted, as by this means all solid matter is kept out of the drains: a very important consideration.

The cart doors should be made sliding, and not hinged, or great inconvenience will be experienced, and they must be made wide enough for the carts to back in easily.

In some slaughter-houses the killing ring to which the beast is attached whilst the blow from the pole-axe is given* consists of a strong horse-shoe shaped piece of iron projecting about 24 inches from the wall at a height of about 18 inches and having a ring in the top curve, thus—

whilst in others the killing ring is on the floor, thus—

and in others an iron pillar standing up from the floor is used, which is considered the best plan, as the beast should stand in a natural and easy position at about a right angle from the feller.

The lighting of the slaughter-house should be effected from the roof, as a good and steady light is essential to the men engaged in this business. An awkward cut may seriously damage good beef or mutton. Care must, however, be taken to exclude the glare of the sun, and the ventilation should be carefully arranged by louvres easily manipulated.

Water should be plentifully laid on at a good pressure, so as to ensure thorough flushing, &c., and the necessary taps should be recessed in the walls, as everything in a building of this description should be kept as flush as possible, or it will be damaged. In some slaughter-houses hot water is laid on,

* The pole-axe should be of the American pattern, which has a head hollow and very sharp round the periphery. The practice is, after the blow is struck and the animal felled, to plunge a thin cane into the wound, which passes down the spine, causing instantaneous death whilst the animal is lying stunned.

and this is a great boon to the butchers and much appreciated by them.

Gas must of course be laid on, as much slaughtering takes place during the night.

The machinery for hoisting the beasts and slinging the carcases requires to be effective, simple, and very strong, as it is subjected to the roughest treatment, and such machinery has been patented and is erected by Messrs. John Meiklejon and Son, of Dalkeith.*

This machinery hoists the beast by simply pulling on an endless chain. It remains suspended at any height, and can be equally easily lowered. The divided carcass can be placed upon hooks at any point along the girders above without being touched, and it can be taken off again and lowered on to a man's shoulders or into the cart direct, and in fact, speaking from my own experience, this machinery is very perfect.

The carcases of the sheep are hung by hand upon hooks projecting from rails which are placed at a convenient height around the walls of the slaughter-house.

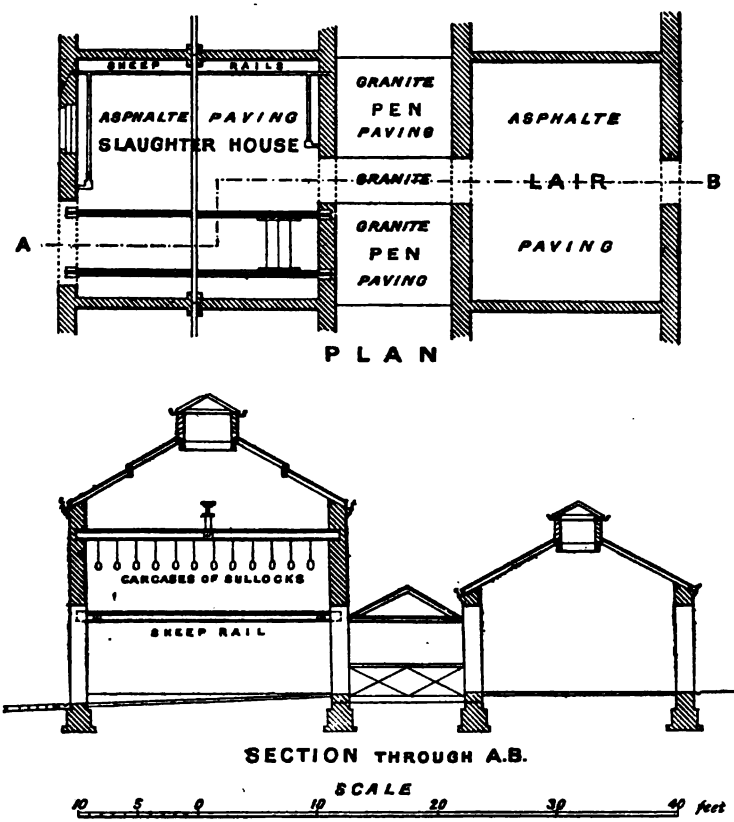
In some abattoirs the sheep slaughter-houses are distinct from those used for killing beasts, and this method has many advantages.

* The following is from the patent specification of this machinery:

"Letters patent to John Meiklejon, of Westfield Iron Works, Dalkeith, in the County of Mid-Lothian, Scotland, for the invention of new or improved machinery and appliances to be used in hoisting, removing, dividing, and hanging on hooks, taking off these hooks again, and loading carcases and other bodies in abattoirs, carcass and meat markets, and other places."

"The machinery and appliances above referred to enable the operations above named to be performed without the necessity of the butchers touching the meat. Also enables carcases to be conveyed from abattoirs to carcass market on a travelling hoist (hereafter described), same being provided with rows of fixed jointed hooks or loops, attached to rails on which the hoist runs, so that the travelling hoist is enabled to hang the carcases or bodies on to such hooks or loops. Also enables a butcher to hang a carcass on any of these hooks or loops, and pick them off again, and load on a vehicle, without moving or touching any of the other carcases hanging on the other hooks. Also enables all operations to be performed, from hoisting when killed to loading when sold or removed from market."

Before proceeding to describe the further requirements of an abattoir or group of slaughter-houses, I think the following plan will be of use to show the arrangement which I have described with regard to lairs and slaughter-houses :—



The plan on the next page shows the arrangements adopted in the Metropolitan Cattle Market slaughter-houses :

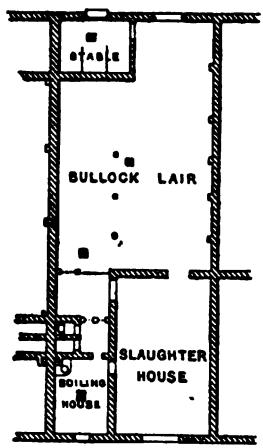
(3.) *The condemned meat department.*

This should consist of a lair for suspected cattle, a lair and slaughter-house for the condemned cattle similar to that already described, and a condemned meat store : this being the place where not only all the diseased animals' carcases are

temporarily stored pending destruction, but also any meat of sound beasts that may have gone bad after killing, &c. The whole of the meat thus placed in the condemned store must be taken to the boiling-down house, where it is destroyed by being boiled down to fat, which is disposed of for various trade purposes.

The following description of the method employed for this purpose at the Deptford Foreign Cattle Market will here be of use: *

"There are several killing houses for diseased cattle, and



METROPOLITAN CATTLE MARKET SLAUGHTER-HOUSES.

excellent apparatus for boiling down condemned meat. For this purpose two boilers are suspended from a strong platform through which they pass, and the bottoms of them are several feet above the floor. They are each 4 feet 6 inches in diameter and 10 feet in length under platform. At the bottom the cylinder tapers to 2 feet 8 inches in diameter. Under this there is a semispherical bottom to the boiler hinged and kept shut by a back-weighted lever and screws. On the top of each there is a semispherical cover and safety valve.

* *Vide* 'Report on the New Cattle Market and Abattoirs proposed to be erected at Carolina Port, Dundee,' by William Mackison, F.R.I.B.A., &c.

There is an iron crane and windlass for lifting off and on the covers. After the boilers are charged with diseased meat the covers are made secure and steam let into them near the bottom. There is a cock in the bottom of each for running off the liquid at certain stages into a trap grating in the floor under it, and conducted into a cement cistern outside of the boiling-house, from which it is periodically removed. Whether any use is made of the tallow produced I am not informed. The bones when removed are quite porous, of a very white colour, and nearly as light as a cork. I presume that they will be sold for being converted into bone manure. I understand these large boilers are not very often used, and that a small close galvanized iron cylinder 2 feet 9 inches in diameter, and 2 feet 6 inches high, placed 15 inches above the ground, having cock at bottom, steam pipe at side, and portable lid, does most of the work very efficiently."

(4.) *The pig-killing department.*

This should be separate from the ordinary slaughter-house, as the styes for pigs must be differently arranged to the cattle lairs, and a boiler house is necessary, as boiling water must be had for scalding and dressing the carcases. Special iron troughs with false bottoms have been arranged by Messrs. Meiklejon, which greatly facilitate this part of the butcher's work, and simple hoisting apparatus over these troughs lifts the carcase in and out, and carries it off to the cooling or hanging room, which must of necessity be separate from the killing and scalding rooms. Drainage, lighting, ventilation and floors should be similar to those described for the slaughter-houses, and plenty of lime wash can be used with advantage here as well as in the main slaughter-house.

(5.) *The blood house.*

The blood of the slaughtered animals, which formerly was allowed to run away, has been found to contain a most valuable aniline dye, and for this purpose it is now collected and taken to the blood-houses, where in order to obtain this

dye it is necessary to place the blood in shallow tins, where it is warmed by steam-pipes, the liquid is then drawn off, which is the albumen from which the dye is extracted, the residuum left in the trays is of the consistency of jelly, and is sold for manure.

(6.) *The tripery.*

This is provided in large abattoirs for the purpose of preparing the tripe and feet of the slaughtered animals, and in the Glasgow public slaughter-houses this is effected by the corporation free of charge by special machinery adapted for the purpose.

(7.) *The tallow market.*

Where tallow is melted down, and moulded in shapes for manufacturer's uses.

(8.) *The hide store.*

This is where the hides and sheep skins are weighed and temporarily stored; sometimes in connection with this are—

(9.) *Sale rooms;* for the hides, skins of sheep, &c., and tallow.

In addition to the above requirements may be mentioned

(10.) *A superintendent's dwelling-house and office.*

(11.) *A gate keeper's dwelling house and office.*

(12.) *A weighing machine and office.*

(13.) *A convenient room* for the meetings of the committee of the corporation having charge of the slaughter-house.

(14.) *Waiting rooms* for dealers, drovers, slaughtermen, and butchers, &c.

(15.) *Store-rooms and a joiner's workshop.*

(16.) *Stables and shedding* for the horses and carts of the jobbers and butchers, &c.

(17.) *Lofts for straw and hay;* the former should be provided free by the corporation, the latter on payment of so much per diem for each beast.

(18.) *The necessary urinal and w.c. accommodation.*

With regard to the provision to be made for storing the

dung and waste refuse from public slaughter-houses, I am strongly of opinion that there should not be any fixed receptacle for such matters, but that covered carts should be provided, which could stand in convenient positions and be removed every day, a fresh and clean cart being substituted at once for the one removed; by this means all nuisance is avoided.

Speaking of public abattoirs, in a lecture on Industrial Nuisances, Dr. C. W. Chancellor, of the Maryland State Board of Health, U.S.A., gave some advice on the management of slaughter-houses. He says: "During the process of slaughtering as much care as possible should be taken to prevent the discharge of blood or other animal matter upon the floor of the slaughter-house, upon the surrounding earth, or into an open stream. The contents of the viscera should, with the blood, offal and other garbage, be placed in impervious, covered, moveable receptacles, constructed of galvanized iron or other non-absorbent material, and removed from the premises without undue delay. Where hides or skins are necessarily retained for a day or two before they can be removed, they might without injury be advantageously brushed over on the fleshy side with a solution of carbolic acid or some other antiseptic. Fat should be freely exposed to the air in a cool place. As soon as the slaughtering is completed the whole slaughter-house, floors and walls, should be thoroughly washed. All the vessels and implements used in the slaughtering should be kept clean and sweet. Deodorizers may sometimes be used with advantage."

There can be no doubt that whereas private slaughter-houses are frequently a most injurious nuisance to the neighbourhood in which they are placed, owing to their situation and construction, and a visit to one of them is likely to give a strong impetus to vegetarianism, the public abattoir, on however large a scale, if properly constructed and managed,

need be no nuisance whatever, and every town in the kingdom should endeavour to obtain one, not only on account of the nuisance caused by private slaughter-houses, but for the incentive which is given to butchers to abstain from slaughtering diseased or unwholesome animals, the prevention of cruelty, and the material benefits derived in a proper establishment for the best methods of dressing the meat.

CHAPTER XXIX.

MARKETS.

UNDER certain conditions urban authorities are empowered to provide markets in their district by the following clause of the Public Health Act 1875:

"Where an urban authority are a local board or improvement commissioners, they shall have power, with the consent of the owners and ratepayers of their district, expressed by resolution passed in manner provided by Schedule III. to this Act, and where the urban authority are a town council they shall have power, with the consent of two thirds of their number, to do the following things, or any of them, within their district:

"To provide a market place, and construct a market house and other conveniences, for the purpose of holding markets:

"To provide houses and places for weighing carts:

"To make convenient approaches to such market:

"To provide all such matters and things as may be necessary for the convenient use of such market:

"To purchase or take on lease land, and public or private rights in markets and tolls for any of the foregoing purposes:

"To take stallages, rents and tolls in respect of the use by any person of such market:

"But no market shall be established in pursuance of this section so as to interfere with any rights, powers, or privileges enjoyed within the district by any person without his consent" (38 & 39 Vic. c. 55, s. 166).

In many towns, markets both for cattle and general merchandise have been already established, and the duties

of the town surveyor are simply to execute the necessary alterations and maintenance of the buildings in connection with them; but there may be occasions on which he has to advise his corporation upon the acquisition of land for the purpose of laying it out as a cattle market, and afterwards the erection of the necessary pens and buildings, and a few remarks upon the subject may be of some service.

The site for a cattle market should be selected, if practicable, near to a railway station, so as to avoid as much as possible the dangerous and objectionable practice of driving cattle and sheep through the streets, and for the same reasons it should be near the public slaughter-houses if there are any in the town. Plenty of space should be provided in the market for the cattle to move about in, for it must be remembered that many of them which are sent to market are unused to the bustle of a town, and are wild and untractable, and have never in their lives been subjected to either penning or tethering.

The site must be easily and effectively drained, it should be somewhat isolated with respect to neighbouring buildings, the more air that can be got to sweep through it the better.

The accommodation necessary in a cattle market must vary considerably with the requirements of the district, but the following list may be given for selection:

(1.) Pens or lairs for fat beasts.
(2.) Pens or lairs for store cattle.
(3.) Pens or lairs for cows with calves.
(4.) Pens or lairs for calves.
(5.) Pens for sheep.
(6.) Pens or styes for pigs.
(7.) Covered sheds or stables for horses.
(8.) A space for showing horses off.
(9.) Sheds for agricultural implements.
(10.) Shops for the display of seeds, ropes, tarpaulins, sacks, etc.

(11.) Accommodation for auctioneers.

(12.) Lodges and offices for the superintendent or gate keeper.

(13.) A weighing machine and office.

(14) A corn exchange (this is sometimes provided in the general market).

The entrance to a cattle market may with advantage be provided with double sets of gates, with a space between in which flocks of sheep or herds of cattle can be temporarily penned; a wicket gate in the second set of gates will enable the toll collector to count the number of animals easily as they pass through into the market.

The paving of the market should be of granite or other stone setts, as it is essential that it should not be slippery, or the cattle, which usually arrive in a very excited condition, will fall and injure themselves; this description of paving is also fairly impervious, and is easily cleansed.

The paving of the lairs and pens may, however, be of asphalte.

For the cattle there may be enclosures for loose bullocks as well as divisions in which the cattle are tethered; these divisions and enclosures may be constructed of brick walls about 4 feet 6 inches in height, or posts and rails of wood and iron, strongly fastened iron rings about 4 feet apart are necessary to which the beasts must be tethered.

The paving must be kept high towards the head of the beast in order to show him off to the greatest advantage.

Large painted signboards should be fixed over the entrance of each compartment, to designate to which class it belongs, in order to avoid confusion or mistake. There should be drinking troughs for all cattle, and hydrants should be fixed all about the market, so that it can be thoroughly flushed and washed down.

The sheep-pens can be constructed with iron or wood posts and rails with the whole of one side opening as a gate;

they should be about 3 feet in height, and the floor should slope up from the point at which the purchaser will stand in order that the sheep at the far end of the pen may not appear diminutive.*

The gates of the sheep-pens should be strongly stayed, as they make most convenient seats on which the drovers and heavy farmers sit whilst they drive their bargains.

With regard to the dimensions of the pens and lairs, the following sizes are suggested as sufficient spaces for different animals, in the modern byelaws, emanating from the Local Government Board in 1877, with respect to markets:

For every horse	8 feet by 2 feet.
For every ox or cow	8 ,, ,, 2 ,,
For every mule or ass ..	5 ,, ,, 1 foot 6 inches.
For every calf	5 ,, ,, 1 ,, 3 ,,

For every sheep, goat or pig (of medium size) 4 feet superficial.

The pens for calves and the styes for pigs should be covered, and their floors should be about 3 feet 6 inches above the general level of the market, as animals of this description are generally brought in carts, and they could thus be easily moved out and in.

These pens and styes must of course be thoroughly well drained and ventilated.

With regard to the weighing machine, this should be of

* The following is a description of the manner in which the sheep are penned in the cattle market of la Villette at Paris—"The enclosure or pens are all of iron, those for the sheep have a centre railing 3 feet 3 inches high, and cross railings 1 foot 9 inches high; the former with three horizontal rails and vertical rods, and the latter two horizontal rails and vertical rods. There is a distance of 15 feet betwixt the high railings, which is divided into three by iron posts 21 inches high. The first row of these posts is placed at a distance of 3 feet from the low cross railing at the passage, the second row 18 inches from the first, the third 3 feet from the second, and so on. The sheep are placed in line side by side as close as they can stand, with their heads up to the low rail. A moveable hurdle of wood is then set on edge between the sheep in the rear and the iron posts just described. A passage, of 18 inches is left clear, and then another row of sheep and another passage, and so on. In this manner a great number of sheep are put into little space, in such a way as all can be examined with the greatest ease." (*Vide* 'Report on the New Cattle Market and Abattoirs proposed to be erected at Carolina Port, Dundee," by W. Mackison, F.R.I.B.A., &c., Town Surveyor, Dundee.)

the best manufacture, and be of sufficient size to weigh a large waggon. It is better to have what is called a "self contained" iron foundation, and pit for the weighbridge rather than one of masonry. A convenient size for this weighbridge would be 15 feet in length by 12 feet in breadth.

With reference to the rest of the provisions I have enumerated, they require no special comment, but must necessarily be left to the discretion of the town surveyor and the wishes of his corporation.

Markets for general merchandise are usually handsome buildings, which are erected in the most central positions of the town; they contain:

(1.) The corn exchange (this is sometimes erected in the cattle market).

(2.) The fish market.

(3.) The dead meat market (this is sometimes erected in connection with the public slaughter-houses).

(4.) The game and poultry market.

(5.) The fruit, vegetable and flower market.

(6.) The butter, eggs and cheese market.

(7.) The miscellaneous goods market.

(8.) Public conveniences.

(9.) Offices and dwelling for the clerk of the market.

(10.) Committee room for the market committee.

The floor of the market should be on a level as much as is practicable with the adjacent streets; steps up or down are objectionable for the public, and galleries or upper floors should also be avoided unless the available area of the site is limited. In order to avoid interference with the floor space the roof should be supported on as few columns as are compatible with safety and economy.

The interior of the building should be lofty, and it must be thoroughly well ventilated; the great fault with nearly all existing markets is the cutting draught to which buyers and sellers are usually subjected.

Plenty of light is essential, but the rays of the sun should be excluded by frosted glass or other contrivance, or the goods exposed for sale will be damaged.

The floor should be of asphalte or other similar material; it is surprising what a "mess" is always made in a market.

The stalls must be so arranged as to show to best advantage the goods offered, and plenty of "gangway" should be left between them for the passage of the public.

Fish stalls should be constructed of iron, slate, or similar material, plenty of water being provided in this department; fish-washing troughs filled with running water are very desirable, and a fountain can be introduced with pleasing effect.

Butchers' stalls should be of thick wood to resist the chopping, and plenty of standards and rails provided with iron hooks must be fixed above them.

A great number of moveable iron "offal boxes" should be placed in different parts of the market, which must be cleared at least once a day, and the market should be frequently flushed and cleansed with water from hydrants fixed in different parts of the building.

Many other points will no doubt suggest themselves to town surveyors, who have the important work of designing either cattle or general markets to undertake, but the few suggestions which have been given may be of some use.

CHAPTER XXX.

CEMETERIES.

AMONGST the many duties that a town surveyor has to perform is sometimes included that of laying out land for a large burial ground or cemetery, and its management after construction. Power is given to all local authorities to become burial authorities by the Public Health Interments Act 1879, and so strongly is the need felt for what is called extramural interment, that the Local Government Board may compel a local authority to provide and maintain cemeteries. Power is also given for the compulsory purchase of land for this purpose (see sections 175, 176, of the Public Health Act 1875), and the cemetery may be placed either within or without the district over which the local authority exercise their jurisdiction, and many other privileges are granted in order to encourage the acquisition of land so far removed from habitations as to make the burial ground as sanitary as the practice of burying human bodies can be made.

In connection with the closing of disused burial grounds and their conversion into recreation grounds, see the Open Spaces Act 1887 (50 & 51 Vict. c. 32), and the Disused Burial Grounds Act 1884 (47 & 48 Vict. c. 72).

A cemetery must not be constructed within 200 yards of any dwelling house, without the consent in writing of the owner, lessee, and occupier of such house; but there is no prohibition upon any one to prevent their building a house close to a cemetery after it has been established.*

* *Vide* 'Fitzgerald's Public Health Act,' p. 131, 3rd edition. Foot note to clause x. Cemetery Clauses Act 1847.

Chapels may be built in cemeteries for the performance of the burial services, and the grounds may be laid out and embellished as the local authority may deem fit. The cemetery must be enclosed by walls or other sufficient fences or iron railings eight feet in height; it must be properly sewered and drained, but such drainage must not flow into any "stream, canal, reservoir, aqueduct, pond, or watering place." *

Cemeteries are divided into consecrated and unconsecrated portions by bond stones or other suitable marks; a chapel must be built upon the consecrated portion, although it does not seem to be compulsory to do so upon the unconsecrated portion.

The selection of a proper site on sanitary and other grounds for a cemetery is one of the greatest importance, and a town surveyor, or anyone who has this duty to perform, cannot do better then keep the following words of the late Mr. Eassie before him: †

"A well-chosen cemetery is one whose soil is dry, close, and yet porous, permitting the rain and its accompanying air to reach a reasonable depth, and so expedite decay. The formation is also well covered with vegetable mould, which assists in neutralising any hurtful emanations, and encourages the growth of shrubs. The subsoil is also of such a kind as to need no under-draining, and such as will prevent the water lodging in any grave or vault. It will also stand exposed to the north or north-east winds which are dry, and which do not hold the putrefactive gases in solution, like the moist south or south-westerly winds.

"An improperly chosen graveyard may be said to be one where the soil is dense and clayey, and impervious to moisture. It will be insufficiently drained, necessitating the use of planks to walk upon in wet weather. It will be too close to

* Cemetery Clauses Act 1847, s. 20.

† *Vide* 'Cremation of the Dead,' by William Eassie, C.E. &c. &c., p. 50.

the abodes of the living, too small to permit proper planting the graves covered, it may be with flat stones which prevent the passage downwards of the air and rain, and surrounded moreover by high walls which exclude the fresh air. The ground will be stony and insufficiently covered with vegetable soil. No natural outfall will exist, and the drainage water must be pumped up, the bare idea of which is horrible. It will be near also to water-bearing strata, or to a reservoir Long before decomposition has taken place owing to the smallness of the site, and the impossibility of obtaining any more land except at high building prices, the organic matter hidden out of sight will be far too large in proportion to the area."

Dr. Parsons, in a memorandum prepared by him on the "Sanitary Requirements of Cemeteries," and published by the Local Government Board in their eleventh annual report, says:

"The soil of a cemetery should be of an open, porous nature, with numerous close interstices, through which air and moisture may pass in a finely divided state freely in every direction. In such a soil decay proceeds rapidly, and the products of decomposition are absorbed or oxidised. The soil should be easily worked, yet not so loose as to render the work of excavation dangerous through the liability to falls of earth. It should be free from water or hard rock to a depth of at least 8 feet. If not naturally free from water, it should be drained if practicable to that depth: to this end it is necessary that the site should be sufficiently elevated above the drainage level of the locality, either naturally, or where necessary, by filling it up to the required level with suitable earth."

"Loam, and sand with a sufficient quantity of vegetable mould, are the best soils; clay and loose stones the worst. A dense clay is laborious to work and difficult to drain; by excluding moisture and air it retards decay, and it retains, in

a concentrated state, the products of decomposition, sometimes to be discharged into graves opened in the vicinity, or sometimes to escape through cracks in the ground to the surface. A loose, stony soil, on the other hand, allows the passage of effluvia."

And with reference to the site to be chosen for a cemetery he further states:

"Nevertheless, in view of the evils which in former times have undoubtedly arisen from the practice of intramural sepulture, and also because the erection of houses near a cemetery interferes with the free play of air around and over it, it is desirable that the site of the cemetery should be in a neighbourhood in which building is not likely to take place; and also that so far as practicable a belt of ground should be reserved between the graves and the nearest land on which a house may be built, in order to obviate to some extent the risk of contamination of ground-air and subsoil water with decomposing matters. This is especially necessary where houses are constructed with cellars. It is, therefore, highly desirable that interments should not be made up to the extreme edge of the cemetery, and it would be possible without great waste of space to reserve in all cases a strip of ground free from interments, 15 to 30 feet in width, around the whole cemetery on the interior of the boundary fence. This strip would afford room, on the inside for a gravel or asphalte walk to give access to all parts of the cemetery, and on the outside next the fence, to a belt of shrubs or trees, the rootlets of which, penetrating the soil, would arrest and assimilate any decomposing matters percolating to the exterior of the cemetery. Obviously a cemetery should not be placed on elevated ground above houses, where the soakings from it may percolate to the sites and foundations of the dwellings below. . . .

"Sites are of course unsuitable which are liable to be flooded or to landslips, or which are in danger of being

washed away, or encroached upon by streams or the sea. Very steep sites are not desirable. The cemetery should be accessible by good roads from all parts of the district."

As to the unsuitability of clay as a soil for cemeteries, Louis Créteur in "Hygiene in the Battle Field" says, that the bodies of soldiers slain during the battle of Sedan were buried in chalk, quarry rubble, sand, argillite, slate, marl, or clay soils, and the work of disinfection lasted from the beginning of March till the end of June. In rubble the decay had fully taken place, but in the clay the bodies kept well, and even after a very long time the features could be identified.

With regard to the amount of land necessary for a cemetery, Dr. Parsons calculates that about a quarter of an acre of land for every thousand of the population of the community to whom the cemetery belongs, is the "usually estimated minimum;" but this is far too small a proportion even for a cemetery possessing every advantage, and he further states, "The desirability of providing more than this bare minimum of space is obvious, and is generally recognised." It must be remembered that as a rule, quite one-sixth of the total area of a cemetery is taken up by the roads, paths, ornamental grass or beds of flowers and shrubs, the chapels, mortuaries, lodges, &c., and sufficient width should be allowed between each grave space to permit every grave being reached without trampling on others; a standard of 110 burials per acre has sometimes been taken, but this appears to me to be rather a small one.

In laying out ground for a cemetery, the following are some points that require careful attention:

(1.) The position of the entrance or entrances; there should if possible be only one, as a lodge is necessary at each, which entails expense.

(2.) The best position for the lodge or lodges, the chapels and mortuary.

(3.) The direction of the roads in the cemetery: these must be wide enough for the hearses and mourning coaches, and there must be convenient places provided for turning round.

(4.) The direction of the paths:* these and the roads should be as straight as possible, so as to economise available burial ground; paths should be sufficiently wide to allow an entrance to be made in them to the adjoining vaults or walled graves, these being frequently covered with a massive tomb or ledger very difficult to remove. The vaults and walled graves, being of a better class, are generally put in the borders of the burial ground, close to the paths.

(5.) In some soils deep and careful drainage is necessary. This should be carried out with ordinary drain pipes laid at a depth of at least 10 feet, and so communicating with each other and the grave spaces, that even in a clay soil each grave as it is sunk should be found free from water.

(6.) Surface drainage, especially of the roads and paths, is also necessary.

(7.) Provision must be made for the disposal of the soil excavated from the graves, as very little punning or ramming of the soil thrown in after a burial should be permitted, and thus there is always a large quantity of material to be otherwise disposed of.

The cemetery must be divided into Church or consecrated ground, Dissenters' ground, and Roman Catholic ground, in such proportions as may be found to suit the particular requirements of the locality in which the cemetery is placed.

These divisions must again be subdivided into sections according to the class and description of the proposed grave, and each of these subdivisions and grave-spaces must be accurately marked with a distinguishing letter and number, so that on reference to a plan and a register book, any person's

* The roads and paths in a cemetery require to be carefully made, in order that they may be available during any weather.

grave may be easily found, however long a time may have elapsed since the interment took place, and although no headstone or mark over the grave is there. It is needless to say that the plan of the cemetery has to be most carefully prepared, and the ground equally carefully set out, to prevent any chance of error occurring, or serious consequences might result. It may be well to remark that no body can be removed after burial without an order from one of Her Majesty's principal Secretaries of State, or by faculty from the Bishop in consecrated ground.*

The following description of the different sections necessary in a large cemetery may here be of use, the fees chargeable for the privilege of burying in each section advancing with the letters appropriated to the sections.

Section A. This is appropriated to workhouse paupers or very poor persons only,† the depth‡ of the grave may be limited to 6 feet, and the size should be 9 feet by 4 feet; only coffins made of wood should be allowed in this section.§

Section B. This is of a slightly superior class to the last, the depth and size may however be the same, but a larger fee

* 20 & 21 Vic. c. 81, s. 25.

† The following is a description of the manner of burying the poorer people in the cemetery of Père la Chaise, near Paris. (*Vide* 'The Parks, Promenades, and Gardens of Paris,' by W. Robinson, F.L.S., &c., p. 109.) "A very wide trench or fosse is cut wide enough to hold two rows of coffins placed across it, and 100 yards long or so. Here they are rapidly stowed in one after another, just as nursery labourers lay in stock 'by the heels,' only much closer, because there is no earth between the coffins, and wherever the coffins, which are very like egg-boxes, only somewhat less substantial, happen to be short so that little space is left between the two rows, those of children are placed lengthwise between them to economise space; the whole being done exactly as a natty man would pack together turves or mushroom spawn-bricks." . . . Let us hope that whatever else may be "taken from the French," we may never imitate them in their cemetery management.

‡ Depth of burial varies from 6 to 10 feet, but there must be 4 feet of earth upon the top of the last coffin if an adult, 3 feet if a child.

§ A proper grave should be dry when opened, and have a sufficiency of soil over the coffin to absorb any gases of decomposition; it should allow an adjoining grave to be opened without collapsing, and should if possible, dispense with the necessity of shoring or close timbering the sides, and should allow sufficient space for a headstone to be placed over it.

can be charged, and the position of the section with reference to the paths should be better and more convenient.

Section C. This is again superior to either of the former sections. Extra depth and size may be allowed, and the position should also be better.

Section D. In the previous sections only "common" graves as they are called should be allowed. In this section either walled graves, vaults, tombs or common graves may be placed; the common graves may be of extra depth and size, the space for a vault may be 8 feet 6 inches by 6 feet.*

This section should be exclusively the borders of the paths and other spots easily accessible and prominent to view.

Section E. This is the best section. No common graves should be allowed in it, and the spaces allotted for burial may be isolated and of various sizes according to agreement and payment. Here costly tombs and monuments are erected, the position of the section being generally near the chapels.†

In all the above sections it is necessary to provide for the burial of children: these require smaller space and in some instances they can be buried with their mother, but in separate coffins. Unfortunately it is necessary to allow rather a large percentage of available space for the interment of children, as the infant mortality in this country is so excessive.

In connection with the question of the plan and the sections for burial, it may be well to give the following rules and regulations for the management of a cemetery:

* In a tomb or walled grave, the coffin should be enclosed in an air-tight case, by means of a stone cemented down which must never again be moved; or concrete may be used. It is a good plan to put some charcoal with the coffin to absorb any gases of decomposition in case of the vault opening accidentally at any future time, and in order to guard against such an occurrence it is better to leave at least 2 feet of earth on the top of the grave below the surface of the ground in walled graves.

† "No body shall be buried in any vault under any chapel of the cemetery or within 15 feet of the outer wall of any such chapel." (*Vide* s. 39, Cemetery Clauses Act 1847.)

Cemetery Rules and Regulations.

(1.) All charges for interment, monuments, and gravestones must be paid at the time the order is granted; no kind of work allowed to be done, or any corpse brought on the ground without the production of an order.

(2.) Certificates of death to be produced (showing the name of the parish, &c., and all other requisite information) on paying the fees.

(3.) Two days' notice to be given for interment in graves, (exclusive of Sunday,) and three days if a vault or brick grave be required. In default, an extra charge will be made for working by night.

(4.) The time when the funeral procession will be on the ground to be named in the notice. An extra fee of will be charged when the funeral procession is minutes later than the time appointed, and for every minutes afterwards.

(5.) The hours of interment are from A.M. to P.M. from Michaelmas to Lady-day, and from A.M. to P.M. from Lady-day to Michaelmas.

(6.) All brick or stone work in the graves, and all foundations and fixing of memorials, or planting, shall be under the supervision and control of the local authority or their appointed agent.

(7.) No grave or vault shall be re-opened by other persons than members of that family without the written consent of the parties interested and of the local authority. An extra fee for the interment of strangers will be charged at the discretion of the local authority.

(8.) In all unbricked graves, coffins of wood only shall be used. No interment will be allowed nearer the surface than four feet for an adult, or three feet for a child under 12 years. Every coffin in a bricked grave or vault to be separately entombed in an air-tight manner.

(9.) No palisades or iron railings to exceed feet in height, except with the special consent of the local authority; and no palisades, or enclosure of any description will be permitted to a grave until a headstone or tomb has been erected.

(10.) A drawing of every monument or gravestone to be submitted for approval, and a copy of the intended inscription if it contains more than name, age, and date. Inscriptions to be arranged so as to face the paths as far as practicable. Any question which shall arise touching the fitness of any monumental inscription, placed in any part of the consecrated portion of the ground, shall be determined on appeal by the Bishop of the Diocese.

(11.) All graves and vaults, monuments, gravestones, fencing or other enclosures, to be kept in repair by the persons interested in their preservation. If suffered to go out of repair and become unsightly, the local authority will remove them altogether, and they will not be allowed to be replaced without the consent of the local authority. Graves will be kept in order by the local authority for a fee of per annum.

A plan of the ground, showing each grave space, is kept at the office of the surveyor to the local authority and may be seen without charge.

The public are admitted to the cemetery, on weekdays, from 7 A.M. to 8 P.M. from Lady-day to Michaelmas, and from 8 A.M. to 5 P.M. from Michaelmas to Lady-day. On Sundays from 2 to 8 P.M. in summer and 2 to 5 P.M. in winter.

All further information may be obtained at the office.

The local authority forbid any gratuity being received by their servants.

The local authority reserves a right, from time to time, to make any alteration in the foregoing charges and regulations.

In connection with the above rules, a scale of fees of the charges for interments must be prepared as well as for head-

stones, foot-stones, ledgers, and tombs, or for enclosing any grave with kerbing, iron-railings, posts and chains, &c.

The practice of allowing persons to plant small shrubs and trees upon the graves of their friends, should be deprecated, as not only do they tend eventually to make a cemetery look untidy, but they are placed so close to the graves that when they grow up their roots often split open a vault or walled grave, and even damage valuable tombstones.

Trees which are suitable for cemeteries, and which would thrive even in a town atmosphere, are the weeping willow, cypress, yew, cedar, juniper, birch, ash, weeping elm, and a considerable number and variety of drooping and other deciduous trees. These should, however, be planted under the control of the local authority, as otherwise a cemetery would soon be overrun by them.

The regulations issued by the Secretary of State for the Home Department in January 1863, for burial grounds provided under the Burial Acts, may be of use for reference, and are given *in extenso:*

(1.) The burial ground shall be effectually fenced, and, if necessary, under-drained to such a depth as will prevent water remaining in any grave or vault.

(2.) The area to be used for graves shall be divided into grave spaces, to be designated by convenient marks, so that the position of each may be readily determined, and a corresponding plan kept on which each grave space shall be shown.

(3.) The grave spaces for the burial of persons above 12 years of age shall be at least 9 feet by 4 feet, and those for the burial of children under 12 years of age, 6 feet by 3 feet, or if preferred, half the measurement of the adult grave space, namely 4½ feet by 4 feet.

(4.) A register of graves shall be kept in which the name, age, and date of burial in each shall be duly registered.

(5.) No body shall be buried in any vault or walled grave unless the coffin be separately entombed in an air-tight

manner; that is, by properly cemented stone or brickwork, which shall never be disturbed.

(6.) One body only shall be buried in a grave at one time, unless the bodies be those of members of the same family.

(7.) No unwalled grave shall be re-opened within 14 years after the burial of a person above 12 years of age, or within eight years after the burial of a child under 12 years of age, unless to bury another member of the same family, in which case a layer of earth not less than 1 foot thick shall be left undisturbed above the previously buried coffin; but if on re-opening any grave the soil be found to be offensive, such soil shall not be disturbed, and in no case shall human remains be removed from the grave.

(8.) No coffin shall be buried in any unwalled grave within 4 feet of the ordinary level of the ground, unless it contains the body of a child under 12 years of age, when it shall not be less than 3 feet below that level.

For further information upon the subject of the Interments Act 1879, and much useful information in connection with cemeteries, I refer my readers to 'Notes and Practical Suggestions upon the Interment Act 1875,' by T. Baker.

I cannot close this chapter upon cemeteries without a few words upon the subject of cremation; as from my official experiences in the practice of burial, I am so deeply convinced that cremation should be substituted for it for very many weighty reasons, that I feel it is necessary for me to give a few of them:

(1.) Nothing can be more unsanitary or dangerous to the living than the burial of the dead. This has been enlarged upon over and over again by men who have well studied the subject and are competent to give an opinion, and to that opinion I add my testimony.*

* It is scarcely necessary to mention the reappearance of the plague at Modena, where 600 years before the victims of a plague were interred, and how similar disturbances of the grave-sites caused immediate outbreaks of disease, or

(2.) Nothing can be more loathesome and degrading to the dead bodies of our friends, or more revolting to our feelings, than the horrible practice of placing the remains of those we love in the soil of a common churchyard or cemetery, to be devoured with other bodies by worms.

(3.) In placing a dead body under ground we can never be sure how long the remains will be left undisturbed, a new street or railway will soon destroy all traces of its resting place,* and even the law only allows a grave to remain undisturbed for a short 14 years.

(4.) In the event of friends or relations dying abroad their remains cannot be sent home for burial except at great expense, cremation would reduce the body to a few silvery ashes which could easily be brought home and secured on arrival in a suitable and safe position.†

(5.) Cremation is the most respectful and beautiful manner for the disposal of dead bodies, as fire is the most perfect

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enhanced the virulence of epidemics, such as cholera and the like. This happened at London in 1854, although the pits had been dug and filled up for almost 200 years. In 1843, when a parish church near Stroud in Gloucestershire was in process of rebuilding, the superfluous soil of the burial-ground was disposed of for manure to the villagers, and the result was nearly a decimation of the place. The outbreak of the plague in Egypt in 1823 was traced to the opening up of a disused burial-ground about 14 miles from Cairo, and thousands perished in consequence.

A recent investigation was made in the cemeteries of Rio de Janeiro, scarcely four years ago, upon earth taken about spade deep from graves where victims of yellow fever had been buried some twelve months previously, and this soil was found to contain "myriads of microbes," selfsame with those present in persons stricken with the same pest at the time of the excavation. A healthy guinea-pig was incarcerated in a space over which earth taken from a grave was sprinkled, and in five days the animal was dead, its blood being found to be "literally crammed" with the germs of the disease in various stages of evolution.

* In a beautiful out-of-the-way valley in Wales, there was a pretty village with a quiet churchyard far from the "busy haunts of man;" yet here it has been found necessary to disinter all the bodies, as this churchyard is now 30 feet under the surface of the water of an immense reservoir supplying the living with drinking water.

† The body of Lord Balcarres was (as is now history) removed from the mausoleum in his own grounds, and only recovered after a most painful interval; this desecration could not have happened had his body been cremated and the ashes suitably secured.

purifyer and type of purity with which we are acquainted and need not alarm (on religious grounds *) any more than the practice at sea of lowering the dead bodies overboard to be eventually eaten and digested by marine animals.

(7.) Cremation is merely a more speedy means of "burning" a body than burial, decomposition being only a very slow and loathesome combustion.

(8.) Cremation would settle at once and for ever the vexed question of burial in consecrated or unconsecrated ground, and all the unseemly quarrels which have taken place in connection with it from time to time.

(9.) The great extent of land that is now wasted in public burial grounds and cemeteries.†

There is no reason, even if cremation should take the place of burial, why the fees to officials and others should not remain as at present, and the unpleasant assistance of the British-ghoul, the undertaker, with his long face at the ceremony and still longer bill afterwards, could easily be dispensed with, or not, at the option of the friends of the deceased.

The opponents of cremation urge that it would be more expensive than burial, and consequently out of the reach of the poorer classes, and also that it would cause so much difficulty in detecting cases of poisoning, that it would tend to encourage persons to poison others who happened to be in their way, and thus crime would go unchecked.

If these are the only objections they are easily to be overcome.

First, by constructing public crematories, where for a few pounds a day sufficient heat could be maintained to consume

* I believe it was Lord Shaftesbury whose remark on this point was, "What would have become of the blessed martyrs, if destruction by fire was to annul their chances of resurrection?"

† The metropolis alone has in addition to the numerous burying grounds near its parish churches, &c. (many of which have been, however, dug up and destr· yed), the average of which it would be difficult to determine, 22 cemeteries with an aggregate area of 2210 acres.

almost any number of bodies,* whilst the present great expense of maintaining large cemeteries with their attendant guardians and other costs would be dispensed with ; and

Secondly, by instituting a scientific and independent enquiry as to the cause of every death which occurs. This is so much required at the present day for the sake of the public health, that even if cremation is never introduced it should be at once enforced, so that those who have charge of the public health could have exact and reliable knowledge of the causes of all the deaths throughout the United Kingdom, and thus obtain such valuable information as would greatly assist in the daily fight to subdue and overcome deaths from preventable causes.

* With either the "Gorini" or "Siemens" systems of cremation very little expense need be incurred if the heat is fairly constantly maintained. The late Mr. Eassie in a paper on "The Economy of Cremation" which he read at a congress of the Sanitary Institute at York in 1886 states that: "If cremation were to replace inhumation a safe calculation shows that the cost (including removal to a near crematory) might be computed thus: For paupers 10*s*. For the working classes 2*l*., for the middle classes 13*l*., &c. (Transactions of the Sanitary Institute, vol. viii. p. 82.)

CHAPTER XXXI.

MORTUARIES.

As the Public Health Act 1875 contains several clauses bearing upon mortuaries, a few words upon this subject will not be altogether inappropriate.

The great and terrible evils arising from the practice of keeping corpses in inhabited rooms by the poorer classes were pointed out by Mr. Chadwick in the year 1843* and the following clauses upon this subject, and the necessity imposed upon the local authority to provide proper mortuaries, are contained in the Public Health Act 1875:

"Any local authority may, and if required by the Local Government Board shall, provide and fit up a proper place for the reception of dead bodies before interment (in this Act called a mortuary), and may make byelaws with respect to the management and charges for use of the same; they may also provide for the decent and economical interment, at charges to be fixed by such byelaws, of any dead body which may be received into a mortuary (38 & 39 Vic. c. 55, s. 141).

"Where the body of one who has died of any infectious disease is retained in a room in which persons live or sleep, or any dead body which is in such a state as to endanger the health of the inmates of the same house or room is retained in such house or room, any justice may, on a certificate signed by a legally qualified medical practitioner, order the body to be removed, at the cost of the local authority, to any mortuary provided by such authority, and direct the same to be buried

* *Vide* 'A Supplementary Report on the Results of a Special Enquiry into the Practice of Interments in Towns,' by Edwin Chadwick, 1843.

within a time to be limited in such order; and unless the friends or relations of the deceased undertake to bury the body within the time so limited, and do bury the same, it shall be the duty of the relieving officer to bury such body at the expense of the poor rate; but any expense so incurred may be recovered by the relieving officer in a summary manner from any person legally liable to pay the expense of such burial.

"Any person obstructing the execution of an order made by a justice under this section shall be liable to a penalty not exceeding five pounds" (38 & 39 Vic. c. 55, s. 142).

From these clauses it would appear that a mortuary or mortuaries are an absolute essential in every town, although it does not appear necessary to have a separate mortuary for any "body of one who has died of any infectious disease," but it may be taken to the mortuary which has been provided for the reception of dead bodies generally. It may also be assumed that bodies may be viewed by a coroner's jury in the mortuary, although a post-mortem examination cannot be made in it, as by the following section:

"Any local authority may provide and maintain a proper place (otherwise than at a workhouse or at a mortuary) for the reception of dead bodies during the time required to conduct any post-mortem examination ordered by a coroner or other constituted authority, and may make regulations with respect to the management of such place; and where any such place has been provided, a coroner or other constituted authority may order the removal of the body to and from such place for carrying out such post-mortem examination, such costs of removal to be paid in the same manner and out of the same fund as the costs and fees for post-mortem examinations when ordered by the coroner (38 & 39 Vic. c. 55, s. 143)."*

It will be observed that the above clause apparently forbids

* Further powers in connection with the removal of bodies of persons who have died of an infectious disease, are conferred by the Infectious Disease (Prevention) Act 1890 (53 & 54 Vic. c. 34).

a post-mortem room being provided at the mortuary, although this would appear to be the most appropriate situation for it, and indeed such a room is frequently provided at or near the mortuary. The reason for this prohibition, especially as it is associated with a workhouse, is evidently to overcome the prejudice which would exist in the minds of the ignorant that the fact of taking a body to a mortuary necessitated dissection: a practice which is looked upon with much disfavour by such persons. As a matter of fact, however, nearly all mortuaries at present constructed are designed with a dissecting or "post-mortem" room attached.

Mortuaries in this country may consist of one of the following descriptions:

(1.) Elaborate groups of buildings, comprising mortuary chapel, coroner's room, post-mortem room, dead-house, waiting rooms, &c., and the necessary care-taker's rooms, and offices.

(2.) Mortuaries in connection with infectious hospitals.

(3.) Mortuaries in connection with general hospitals.

(4.) Mortuaries at cemeteries or licensed burial grounds.

(5.) Dead-houses provided by the sanitary authority.

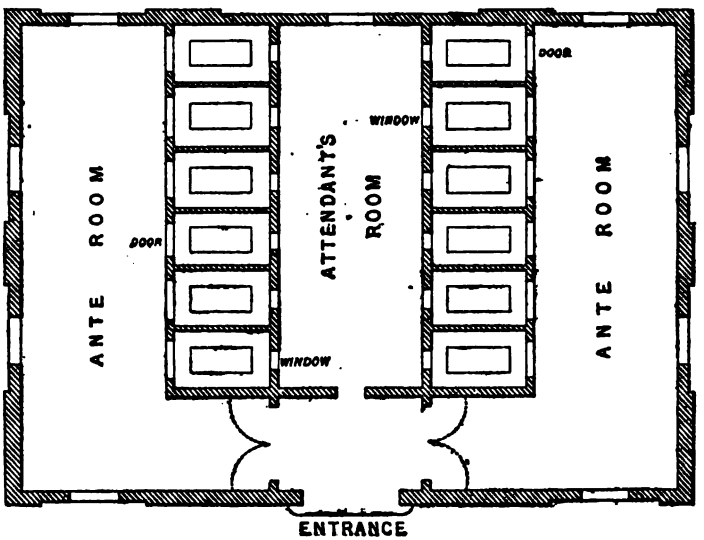
In arranging for the erection of a dead-house or mortuary in any town, the surveyor may find the following particulars and suggestions of some use to him:

A mortuary must be provided in the grounds or near all cemeteries that are in active operation; but in addition to these, others ought to be erected in central positions of the town, so that bodies can be easily conveyed there, not only with a view to meet the objections mentioned in the opening of this chapter, but also to avoid the unseemly practice at present so largely in vogue of taking any cases of sudden death, suicide, accidental drowning, violence or accident, &c., that may occur, to the nearest public house, there to await identification and the coroner's inquest.*

* There is no law that can compel any one to receive a dead body into his house.

In Frankfort mortuaries have been for some years in existence; they are simple buildings, with a separate room for each corpse, intended not only to prevent bodies from being kept in private houses, but also to lessen the chance of any person being buried alive. The following is a plan of one of these institutions:

To prevent the chance of burying any person alive, each corpse as it is placed in its little dead-house has a ring placed upon its finger; this ring is attached to a string which is in



PLAN OF A GERMAN LEICHENHAUSER OR DEAD-HOUSE.

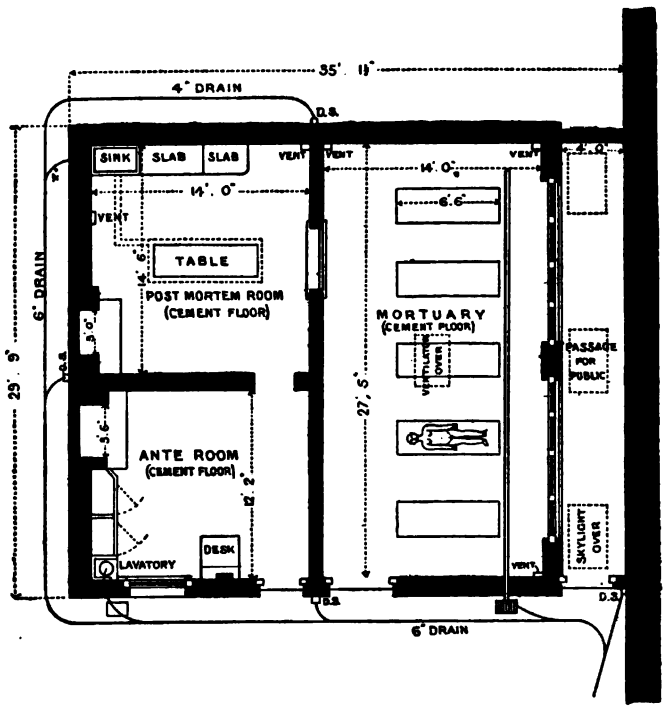
communication with a bell which hangs in the attendant's room, who is there night and day, a window communicates with each dead house, so that on the alarm being given he is at once ready to render assistance.

In Paris, as is well known, all bodies that are found are placed in the "Morgue" behind "Notre Dame," where they are publicly exhibited, thus assisting identification, although the exposure of bodies in this manner is not very attractive. The following plan however, of an existing Dead-house may

be taken as illustrating the ordinary requirements of an English Town.

In preparing designs for a group of buildings such as are set forth in the first on the list which I have given, the following requirements should be considered :

The Mortuary Chapel should be of such dimensions as are suitable for the requirements of the district, bearing in mind that if an epidemic of a fatal character was to unfor-



PLAN OF A MORTUARY.

tunately break out, it could either provide accommodation for the extra strain upon it, or be capable of being easily extended. It should be designed so as to combine the characteristics of a chapel with the most perfect sanitary arrangements.* The

* It is important to remove the idea of a "parish dead-house," otherwise its object will be defeated, as persons will object to allow the bodies of their deceased friends to be taken to it.

walls should be of stone lined with glazed tiles, and everything should be kept as flush as possible so as to avoid projections on which dust could accumulate, the whole being easily and readily cleansed and disinfected. The floor may be of asphalte or other impervious material, and be well drained, great care being of course taken to exclude rats.

The ventilation must be perfect, the building should always be of low temperature even in the hottest days of summer, any windows should be in the north side, or else external louvre blinds should be provided. All the group of buildings should, if possible, be surrounded by a free belt of air. Their position should be isolated with respect to other buildings, and of course it is highly necessary that they should be as far away as possible from any dwelling-house, a disused burial ground being sometimes selected as a convenient site; in fact they should as much as possible be isolated and unobtrusive. The furniture of a mortuary chapel should consist only of trestles or of brackets against the walls upon which to rest the shells containing the corpses.

The Dead-house should be a room smaller than the mortuary chapel, but its construction may be the same. It is here that all bodies should be brought uncoffined for the purpose of awaiting identification, or preparatory to post-mortem examination, or of bodies of those who have died from dangerous contagious maladies, and rendering immediate removal necessary; these are placed upon slate tables at a height of about 3 feet from the floor. In conjunction with the dead-house should be—

The Post-mortem Room, which requires plenty of light; it must also, like the mortuary chapel and dead-house, be thoroughly ventilated and drained and be easily cleansed. Its furniture must consist of the necessary post-mortem table of slate, zinc, or wood covered entirely with lead: this table must slightly dish towards the centre and be drained into a pail or on to a grating. Plenty of water is essential, con-

veniently laid on, and the room must be fitted with good arrangements for gas or other means of artificial lighting. Some method is also necessary for the purpose of heating water whenever it is required.

The Coroner's Court may be simply a large room with convenient seatings and tables for the coroner and his jury, accommodation being also provided for the press, witnesses, &c., with the necessary retiring rooms and offices.

In addition to the above requirements the following accommodation should also be provided:

A caretaker or *resident attendant* should have accommodation at or near the main group of buildings.

A Laboratory and Weighing Room should also be provided in connection with the post-mortem room; and a *Store Room* for spare shells and disinfectants, &c.*

If possible also it is well to provide a *Hearse House*; and in connection with the mortuary establishment, the disinfecting of bedding, clothing, &c., which have become infected, should also, if possible, be carried on.

Before, however, proceeding to discuss the question of disinfection, I will give the following drawing (see next page) of a mortuary chapel, &c., as proposed by the late Dr. W. Hardwicke, the well-known Coroner, in a valuable paper upon the subject of Public Mortuaries which he read before the Royal Institute of British Architects in the year 1869:

With reference to the question of disinfection, which as I stated can be conveniently taken in connection with that of mortuaries, the following is the clause of the Public Health Act 1875 which deals with it:

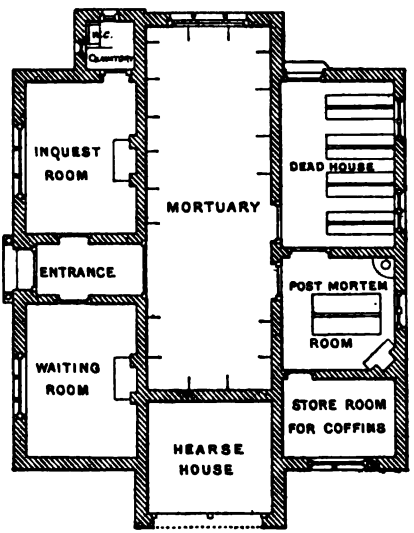
"Any local authority may provide a proper place, with all necessary apparatus and attendance, for the disinfection of bedding, clothing or other articles which have become infected,

* For further information on the subject of the erection of Mortuaries, read the Model Byelaws (No. xv. Mortuaries), issued by the Local Government Board in 1882 for the use of Sanitary Authorities.

and may cause any articles brought for disinfection to be disinfected free of charge (38 & 39 Vict. c. 55, s. 122). See also 38 & 39 Vic. c. 55, ss. 120 and 121.

For the purposes of disinfection it is necessary to "provide a proper place;" and in order to centralize this place as much as possible, no more convenient or "proper" place can be found than near to the Mortuary.

If there is a refuse destructor in the town, this neighbourhood might also be selected as a convenient and proper site



for obvious reasons, and in connection with this the waste heat from the destructor might be employed for the purpose of disinfection.

Up to the present time the disinfection of articles of clothing, bedding, &c., has been effected either by dry heat maintained at a temperature of from 220° Fahr. to 240°,* steam boiling under pressure at a temperature of 212°, or simple washing in boiling water.

* At a dry heat of 250° light textures, such as white wool begin to scorch, which of course must be avoided.

When the articles are at all stained, it is necessary to wash them before applying either dry or steam heat, as otherwise the heat fixes the stains permanently.

Steam penetrates nearly all articles more rapidly than dry heat, especially where the former is applied under pressure ; but the effect of steam upon leather or other articles which suffer from moisture is detrimental to this method of disinfection.

The following are the points to be aimed at in the selection of the "necessary apparatus" to effect the proper disinfection of articles under the Act.

Uniform distribution of heat throughout the whole of the interior of the chamber, and this heat must be constantly maintained at a given temperature, a trustworthy index of this interior heat must be plainly visible to the attendant, who must have some simple means for regulating it under his control, or better still, it should be automatic in its action. The apparatus should not be costly of construction or maintenance, and it should be rapid in its action.

The points to avoid are scorching, which produces changes of colour and texture, and weakens the textile strength of articles. Overdrying, which renders articles brittle. The fixing of stains so that they will not afterwards wash out. The melting of fusible substances such as wax and varnish. Alteration of colour of any of the articles or of the gloss, &c. of dyed and finished goods, or any shrinkage or cracking, &c.

A great number of machines have been from time to time invented for the purpose of achieving the objects I have enumerated, some of which are no doubt familiar to my readers. I believe the following list comprises the names of the machines which are at present best known.

Benham's, Bradford's, Fraser's, Heron Roger's, Jennings', Leoni's, Longstaff's, Washington Lyon's, Nelson's, Ransom's, Scott's, Taylor's.*

* For further information upon Disinfecting Machines see "extracts from the Annual Report of the medical officer of the Local Government Board for 1884, Disinfection by Heat, being a report by H. F. Parsons, M.D." (Printed in 1886.)

It is necessary that the Local Authority should make provision for the collection and removal of the infected clothing and bedding from the infected houses, in such a manner as will reduce to a minimum any risk of spreading infection during the process of removal. For this purpose covered and hermetically sealed vehicles should be provided by the local authority of the necessary pattern, in which the articles can be removed from the houses to the disinfecting apparatus with as little handling as possible.

Before concluding my remarks on disinfection, it is well to state that plenty of carbolic acid should be kept in a mortuary. Sheets saturated with carbolic acid are used to wrap around the dead bodies of infected persons, and sawdust saturated with carbolic acid can be freely used with great advantage.

CHAPTER XXXII.

BORROWING UNDER THE LOCAL GOVERNMENT BOARD.

THERE are a number of clauses in the Public Health Act 1875, which empower a local authority to borrow money on the credit of the rates for the purpose of "defraying any costs, charges and expenses incurred or to be incurred by them in the execution of the Sanitary Acts" (*Vide* 38 & 39 Vic. c. 55, s. 233.)

The exercise of these powers of borrowing are subject to the followings regulations :

(1.) Money shall not be borrowed except for permanent works.*

(2.) The sum borrowed shall not exceed at any time, including all outstanding debts, the assessable value for two years of the district.

(3.) Where it exceeds the value of one year, the Local Government Board will not give their sanction until one of their inspectors has held a local enquiry.

(4.) The money cannot be borrowed for a longer time than 60 years, and it must be paid off within that time.

(5.) Certain regulations as to sinking funds, &c. (*Vide* 38 & 39 Vic. c. 55, s. 234 *et seq.*)

The power to borrow money thus granted to local authorities has undoubtedly given a considerable stimulus to the execution of important sanitary works which could not be carried out if they had to be paid for out of the current

* The Local Government Board have held a steam roller, a steam pumping engine, a steam fire-engine, a stone crushing machine and closet tubs for the use of the poorer classes, to be "permanent works." *Vide* 'The Law of Public Health,' Glenn, 10th edition, p. 446.

rates. It is also a fair and equitable arrangement that permanent works should be paid for by those that reap the benefit of them, and it is now so arranged that the money borrowed is repaid within a certain specified time by equal annual payments, in order that the ratepayer of the present shall not be unduly taxed for the benefit of posterity.

No regular or fixed times have been settled by the Local Government Board over which they will allow the repayment of loans to be spread; but it appears that the duration of the proposed works somewhat guides the length of time allowed, as will appear from the following list:—

CEMETERIES.

(1) Land	30 to 50 years
(2) Buildings— (*a*) Chapels, (*b*) Caretakers' Lodges	30 years
(3) Laying out and planting	20 ,,

FIRE APPLIANCES.

(1) Fire engines— (*a*) Steam, (*b*) Manual	10 years
(2) Fire escapes	10 ,,

LIGHTING.

(1) Gas works—	
(*a*) Purchase of existing works	The period varies according to condition of the works.
(*b*) Construction of new works	15 to 30 years
(2) Lamps and lamp columns	10 years
(3) Electric Lighting	10 ,,

MISCELLANEOUS.

(1) Refuse Destructors	20 years
(2) Steam Rollers (3) Horse Rollers (4) Stone Breakers	10 ,,
(5) Disinfecting Apparatus	10 to 20 years
(6) Urinals	10 years

(7) Public Walks and Pleasure Grounds	50 years for purchase of land, 20 years for fencing and laying out.
8) Bridges	20 to 30 years
(9) Seats and Shelters	5 to 10 years for seats. The period for shelters is according to the nature of the building.
(10) Telephonic Appliances	10 years

PRIVATE STREET IMPROVEMENTS.

The period allowed is usually the same as that given to the owners for repayment of the cost of the works. Sometimes a year is added to cover the time spent in the execution of the works, but it is not usual to let the period for the loan exceed ten years.

PUBLIC BUILDINGS.

(1) Hospitals—	
(*a*) Temporary	The period depends on the special circumstances of each case.
(*b*) Permanent	30 years
(*c*) Floating	
(2) Baths	30 years
(3) Offices	30 ,,
Furniture	10 to 15 years
(4) Municipal Buildings	30 years
Furniture	10 to 15 years
(5) Public Libraries	30 years
Books	6 to 10 years
(6) Slaughter Houses	30 years
(7) Markets	30 ,,
(8) Stables	20 to 30 years
(9) Depôts	30 years
(10) Fire Engine Stations	20 to 30 years
(11) Mortuaries	30 years

PUBLIC STREET IMPROVEMENTS.

(1) Land	30 to 50 years
(2) Road formation—	
(*a*) Macadam	5 to 10 ,,
(*b*) Granite blocks	20 to 30 ,,
(*c*) Wood	10 years
(*d*) Asphalte	10 ,,

(3) Kerbing and Channeling	20 years
(4) Paving Footways—	
(*a*) Tar	10 ,,
(*b*) Gravel	10 ,,
(*c*) Asphalte	10 ,,
(*d*) York paving	20 ,,
(*e*) Victoria Stone	20 ,,
(*f*) Granolithic	20 ,,
(*g*) Brick	10 to 15 years

SCAVENGING.

(1) Horses	10 years
(2) Carts	10 ,,
(3) Harness	No loan has been sanctioned for this purpose separately.
(4) Water Vans	10 years
(5) Sea water for street watering	30 years for works, such as pipes; machinery would have 10 to 15 years.

SEA DEFENCES.

(1) Groynes	10 to 30 years
(2) Sea walls	20 to 30 ,,
(3) Esplanades	20 to 30 ,,

SEWERAGE.

(1) Sewerage Works	30 years
(2) Land	50 ,,
(3) Sludge Presses	10 ,,
(4) Machinery—	
(*a*) Pumping Machinery (*b*) Engines	10 to 15 years
(5) Sewage Farm Stock	10 years
(6) Labourers' Cottages, &c., on Sewage Farm	20 to 30 years

WATER SUPPLY.

(1) Water Works	30 years
(2) Land	50 ,,
(3) Machinery—	
(*a*) Pumps (*b*) Engines, Gas, Steam	10 to 15 years
(4) Water Towers	30 years

Whenever a local authority decide to make application to the Local Government Board for power to borrow money

for any proposed improvements or works within their district, it is the duty of the town surveyor to prepare the necessary drawings and obtain the required information in order to fill in the forms which are supplied from the Local Government Board office.

With reference to this important part of his duty, I cannot do better than give the following Suggestions as to the Preparation of Plans of Proposed Works, by Sir Robert Rawlinson, C.B., C.E., &c. (Chief Engineering Inspector to the Local Government Board), prepared by him in 1878:

"It will in all cases be necessary, upon application being made for sanction to a loan, for the execution of works, that plans (or tracings of the plans), sections, estimates in detail and specifications be submitted with the application, accompanied by information as to the population at the two last periods of the taking of the census, the rateable value of the district, and the amount of outstanding loans."

"Such plans or tracings may be used for showing lines of main sewers, drains, water-pipes and gas-mains. The lines of main sewers, and drains should have the cross sectional dimensions of the sewers and their gradients distinctly marked (written and figured) upon them. The dimensions of water and gas pipes should also be shown in figures or by writing."

"N.B.—No general map should be submitted which is drawn to a scale of less than 6 inches to a mile, except when the inch ordnance map is used."

"Maps upon which sewerage works or water works are to be shown, or for street improvements, should be not less than the ordnance scale of $\frac{1}{2500}$th."

"The sections should be drawn to the same horizontal scale, and to a vertical scale of 20 feet to 1 inch."

Any detailed plan for the purposes of house drainage, paving, the purchase of land, &c., should be "constructed to a scale of not less than 10 feet to a mile, and upon this plan

should be exhibited all houses and other buildings, bench marks, the levels of streets and roads, of cellars, of the sea at high and low tide level, and the summer and flood levels of rivers. 3 feet by 2 feet will be a convenient size for the sheets of this plan."

"Enlarged detail plans and sections of sewers, side entrances, man-holes, sewer sluices, sluice valves, water-pipe joints, and similar details, should be to a scale not less than 8 feet to 1 inch, and for some details 4 feet to 1 inch."*

"As it may occasionally be desired to carry out works piecemeal, with a view to save the time which would be occupied in the preparation of a complete plan from actual survey, it will be sufficient in the first instance to furnish any available general plan of streets and roads, with the surface levels and those of the deepest cellars figured in feet and inches, and the proposed scheme of works shown (or sketched) thereon, after which the works can proceed in sections. It should be understood, however, that a complete plan of the entire district must be proceeded with, so that when the works are finished, the sanitary authority and this Board may possess a proper record of them."

And again, Sir Robert Rawlinson in the same year, at a meeting of the Association of Municipal and Sanitary Engineers, writes as follows:

"Plans should be neatly and clearly drawn, the cross sectional dimensions and the gradient being written on the *plan* of sewers; there should be a title and scale on each plan, as also on each sheet, and the date with the name of the engineer or surveyor clearly written so as easily to be read; this as a rule should be in the right-hand corner. Many

* Details may be drawn to any scale larger than the dimensions named. Engraved or lithographed diagrams, if clear and distinct, will be accepted. A new plan of any town or district cannot be used for main sewering, water supply, gas supply, pavements, footwalks, and other purposes without spoiling it; consequently it had better be retained as a standard and be zincographed, there may then be copies for all local purposes. The zinc plates to be the property of the local authority.

names are so written that experts cannot read them, and plans are frequently sent out having no title, nor any scale, nor any name.

"Plans of details, such as side entrances, man-holes, flushing chambers, and sewer ventilating arrangements, should be at feet to an inch, larger works may be at 4, 10 to 20 feet to an inch. Clear understandable and measurable details are desirable. . . . I have much trouble in looking over defectively prepared plans and crude ill-understood and ill-digested schemes, as they are submitted to the Local Government Board, for approval and sanction to a proposed loan. One great fact connected with the Board must not, however, be overlooked. It is not an office of works, it does not undertake to devise, neither does it make itself responsible in any degree for the plans or for the estimates which may have been sanctioned. Each engineer and each local authority must both devise and execute the local works, and the district must alone be responsible for the local expenditure. The Board neither dictates as to works, nor superintends works, but reserves the power of refusing sanction to a proposed loan, and of requiring full explanations as to failures in the works, or as to expenses over estimates before sanctioning a supplemental loan. The reason that the Board declines responsibility ought to be clearly manifest; plans and details may be the best possible, but the ultimate result depends on daily local supervision, and this the Board does not give; neither local action nor local responsibility is superseded."

Speaking on this point at the first meeting of the Sanitary Institute of Great Britain held at Croydon in 1879, Sir Douglas Galton, C.B., said :*

"Where a loan is applied for, the plan upon which the money is to be spent is submitted for Government approval. The Government only lends the money after the approval

* *Vide* 'Transactions of the Sanitary Institute of Great Britain,' vol. i. p. 116.

of the proposed scheme of expenditure by one of their inspectors.

"The Local Authorities of the towns to be drained cannot therefore be responsible for the plan selected, for the Local Authorities must alter their plans to suit the views of the inspector. The responsibility of the engineer is diminished because he may be compelled to modify his plan in a manner of which he may not thoroughly approve, and the inspector has no responsibility in the matter, because, after having approved of the general scheme, he has no control over the details or the execution of the work, nor can he be in any way held responsible, if the result were a failure."

CHAPTER XXXIII.

CONTRACTS.

CONTRACTS being principally a legal question, it is not my intention to say much on the matter.

In the Public Health Act, 1875, will be found the following clauses:

"Any Local Authority may enter into any contracts necessary for carrying this Act into execution (38 & 39 Vic. c. 55, s. 173).

"With respect to contracts made by an Urban Authority under this Act, the following regulations shall be observed (namely):

"(1.) Every contract made by an Urban Authority whereof the value or amount exceeds fifty pounds shall be in writing and sealed with the common seal of such authority:

"(2.) Every such contract shall specify the works, materials, matters or things to be furnished, had or done, the price to be paid, and the time or times within which the contract is to be performed, and shall specify some pecuniary penalty to be paid in case the terms of the contract are not duly performed:

"(3.) Before contracting for the execution of any works under the provisions of this Act, an Urban Authority shall obtain from their surveyor an estimate in writing, as well of the probable expense of executing the work in a substantial manner as of the annual expense of repairing the same; also a report as to the most advantageous mode of contracting, that is to say, whether by contracting only for the execution of the work, or for executing and also maintaining the same in repair during a term of years or otherwise:

"(4.) Before any contract of the value or amount of one hundred pounds or upwards is entered into by an Urban Authority ten days' public notice at the least shall be given, expressing the nature and purpose thereof, and inviting tenders for the execution of the same; and such authority shall require and take sufficient security for the due performance of the same.

"(5.) Every contract entered into by an Urban Authority in conformity with the provisions of this section, and duly executed by the other parties thereto, shall be binding on the Authority by whom the same is executed and their successors, and on all other parties thereto and their executors, administrators, successors or assigns to all intents and purposes: Provided that an Urban Authority may compound with any contractor or other person in respect of any penalty incurred by reason of the non-performance of any contract entered into as aforesaid, whether such penalty is mentioned in any such contract, or in any bond or otherwise, for such sums of money or other recompense as to such Authority may seem proper" (38 & 39 Vict. c. 55, s. 174).

In reading the numerous foot-notes that follow the above clauses in Glenn's 'Law of Public Health and Local Government,' it will be seen that contracts with corporations have been held to be very different from ordinary ones between individuals or companies. All contracts should be by deed under the seal of the corporation, or "there is no safety or security for anyone dealing with such a body on any other footing," and this applies also in "respect of any variation or alteration in a contract which has been made." I strongly advise all town surveyors to carefully read these foot-notes to which reference has been made, before making any contracts for his Council or Board.

"A committee of the corporation has no power to enter into any contract" (38 & 39 Vict. c. 55, s. 200).

A member of a corporation may not be "concerned in any

bargain or contract" entered into by the corporation, although this would not vitiate the contract (38 & 39 Vict. c. 55, s. 11, clause 64), neither may an officer of the corporation be "concerned or interested in any bargain or contract" (38 & 39 Vic. c. 55, s. 193).*

It is, of course, necessary before any contract can be entered into, that the town surveyor should prepare the specification, schedule of prices and drawings where necessary; this entails a considerable amount of work.

In addition to ordinary specifications for works, the town surveyor has often to prepare specifications and schedules for the supply of the following goods:

Ironmongery.	Paving.
Paints, etc.	Clothing.
Disinfectants.	Stationery.
Castings.	Horse hire.
Coals.	Cement.
Harness.	Lime.
Fodder.	Timber.
Road metal.	Gravel.

and a host of other things too numerous to mention.

A well-written, clear, and comprehensive specification is a most difficult thing to write; but it should be "common sense" from beginning to end, any legal phraseology being left to the town clerk to introduce in his "deed" as required by the Act.

For sewer and drain work lump sum contracts are often undesirable: it is better to work according to a schedule of prices, and periodical measurements.

It must not be forgotten that in all contracts the contractor seeks to make a profit out of the work; if there is no intermediate contractor this profit goes to the ratepayers. In most sanitary works also the men employed by the local authority are more skilled in that particular class of work than the chance men employed by a contractor, and for this and many other

* See also Public Health (members and officers) Act 1885 (48 & 49 Vic. c. 53).

reasons, administration by the local authority is in most cases preferable to contracts.*

Where tenders have been invited by advertisement or otherwise, the successful person should be written to, apprising him of the fact, and requesting him to call, sign the necessary specification, deeds, and drawings; an intimation should also be made to the unsuccessful competitors that their tenders have not been accepted.

At the conclusion of the first edition of this work I gave a list of books which I had studied in connection with its preparation; but since then I have read so many excellent books and pamphlets that it would take too much space and serve no very useful purpose were I to recapitulate them. My thanks are none the less due to their authors for the assistance which has thus been rendered me.

* Mr. Parry, C.E., Borough Surveyor of Reading, says, "My experience of such works is that town authorities can obtain both labour and materials cheaper than contractors, and with efficient supervision the work costs less money." (*Vide* 'Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. iv. p. 89.)

reasons, administration by the local authority is in most cases preferable to contracts.*

Where tenders have been invited by advertisement or otherwise, the successful person should be [illegible] for approving him at the bid and requesting [illegible] the necessary specification, sketch, and drawings [illegible] should all be made by the [illegible] have not been [illegible].

At the conclusion of the first edition of this work I gave a list of books which I had studied in connection with its preparation, but [illegible] and pamphlets that [illegible] no way [illegible]. My thanks are now [illegible] to their authors for the assistance which has thus been rendered me.

* Mr. [illegible] Harry, [illegible], Borough Surveyor of Reading, says, "My experience of such works is that [illegible] both labour and materials cheaper than contractors, and with [illegible] supervision the work [illegible]." ('Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors,' vol. iv. p. 80.)

INDEX.

M.

N.

S.

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V.

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Y.

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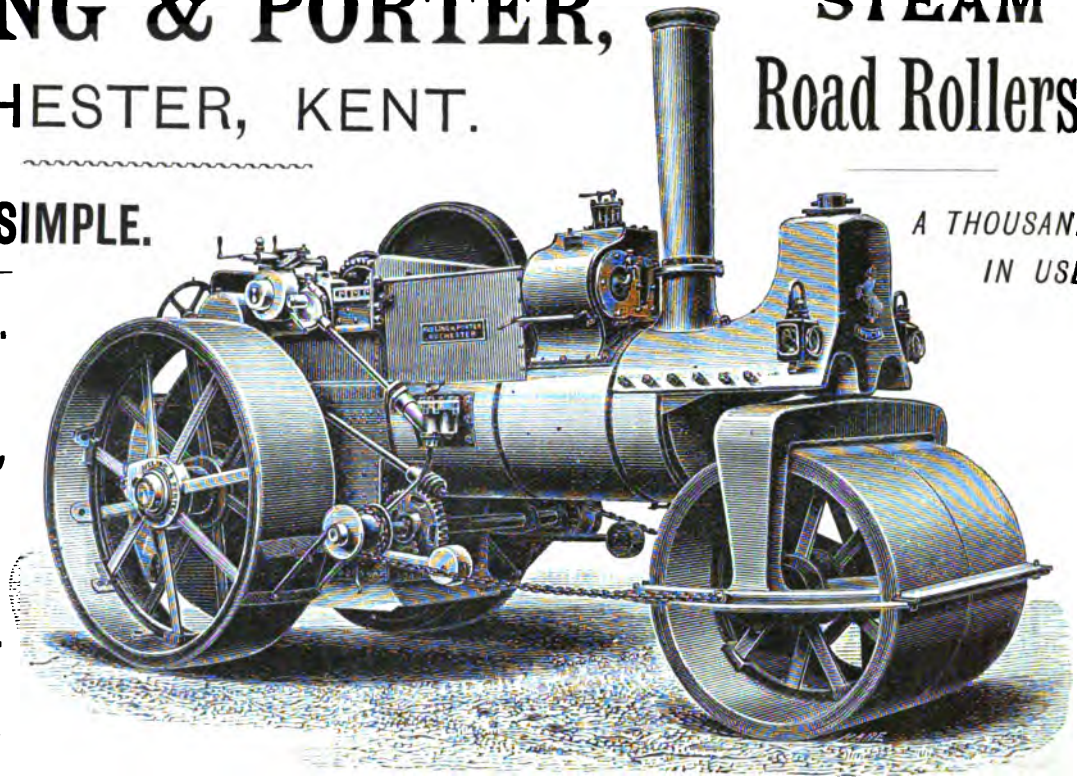
FOR
Adapting the Rollers to the contour of Road.

PATENT
ARRANGEMENT
FOR
REDUCING WIDTH OF ROLLER.



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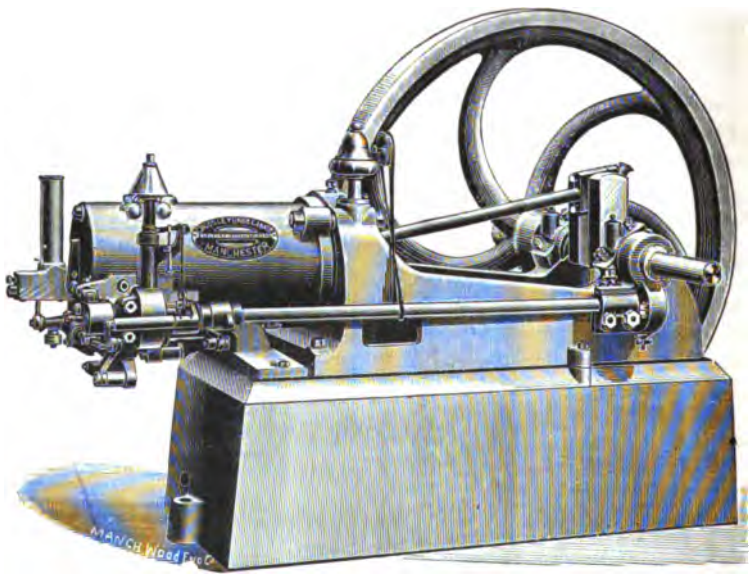

NOTE.—Crossley Bros.' Ltd., own Works, requiring from 250 to 300 H.P., are entirely driven by their Otto Gas Engines working with Dawson Economic Gas, for a consumption of 1½ lbs. of Anthracite Coal per H.P. per hour.

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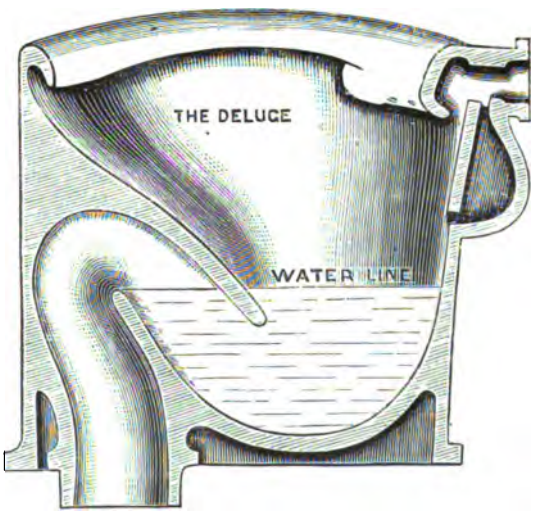


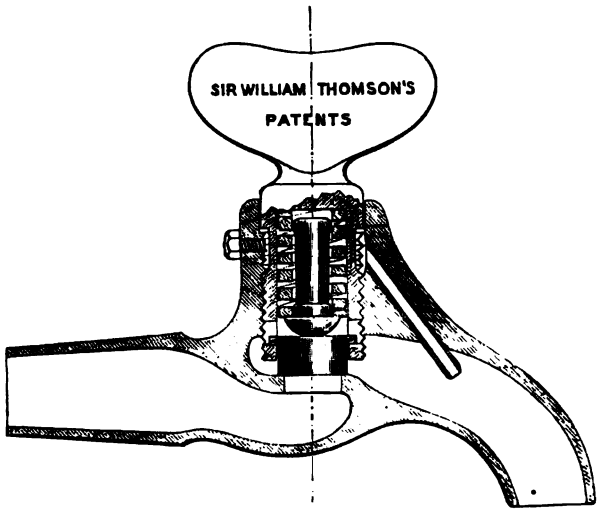
SPECIAL ADVANTAGES.

IMPROVED Formation of Basin and Trap.
PATENT Flushing Arrangements.
COMPLETE Washing of Basin.
THOROUGH Clearing of all Contents through Trap.
LARGE Surface of Water in Basin.
DEEP Water Seal in Trap, fully 2 inches.

TWYFORD, Cliffe Vale, Hanley.

SIR WILLIAM THOMSON'S
PATENT
Indestructible Water Taps.

These Taps have been opened and closed under water pressure for the equivalent of more than 50 years (30 times a day) without any deterioration. The ordinary rubber, fibre, or leather washer valve, and the packing or washer around the spindle, are entirely dispensed with. Perfect water-tightness is nevertheless attained.



By the invention of this indestructible water tap, Sir WILLIAM THOMSON, D.C.L., LL.D., President of the Royal Society, &c., the author of many other useful inventions, has effected what previous inventors have unsuccessfully attempted. By an ingenious device the metallic valve and its seat retain their burnished condition for an indefinite period. The taps are made of the best metal throughout, and are equally suitable for boiling and cold water, are tested to 300 lbs. per square inch before leaving the works, and are sold at a lower price than equal qualities of ordinary firms by the

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Manchester Ship Canal.
Birmingham Cable Tramway.

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Combined Lamp and Ventilating Column for Constant Discharge of Disinfected Sewer Gas.

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Continuous Disinfection of Sewer Gas by a Scorching Heat.

TESTIMONIAL AFTER THREE YEARS' WORKING.

We have had KEELING-HOLMAN'S SEWER GAS EXHAUSTERS AND DESTRUCTORS in continuous use in this district during the last three years. We have discontinued the use of open sewer gratings in the streets and sewer ventilating pipes on the roofs of houses, preferring, in the interest of the public health, to destroy all foul and noxious sewer gases by causing t hem to pass through a destructive heat. We have nine in use, and shall erect others on the new sewers now in course of construction. WALTER BROOKE, A.M.I.C.E, Borough Surveyor, Richmond. *November* 5, 1890.

SECOND TESTIMONIAL AFTER THREE YEARS' WORKING.

We have seventeen Destructors distributed over the city, acting upon approximately twenty miles of sewers, and as they are in constant action I have no anxiety from the fear of sewers getting foul in any kind of weather.
WM. GAMON, City Surveyor, Winchester. *November* 11, 1890.

TESTIMONIAL AFTER ONE AND A HALF YEARS' WORKING.

I have pleasure in stating that the Destructor which you supplied last year has been in operation ever since, and continues to work to my entire satisfaction. ARTHUR SALMON, Surveyor, Wallasey Local Board. *November* 21, 1890.

TESTIMONIAL AFTER THREE YEARS' WORKING.

Referring to HOLMAN-KEELING'S PATENT SEWER GAS DESTRUCTORS, the best testimonial I can give is simply to state the fact that we erected two as an experiment in 1887, five more in the following year; subsequently we made the number up to twelve, and are now about to erect three others. This will make the number fifteen up to date.
CHARLES JONES, A.M.Inst.C.E., Engineer and Surveyor, Ealing.

The Street Lamps are now used as Sewer Ventilators in conjunction with the Destructors, thus increasing the quantity exhausted from the sewers, without any additional cost for gas.

HOLMAN'S PATENT FLASH-LIGHT BURNERS enable the Lamps to be lit by applying the light outside the lamp column

The Sanitary Authority of Richmond passed the following Resolution, under date December 3, 1889:—
"That Mr. Holman be informed that the Vestry have great pleasure in bearing testimony to the success of KEELING'S SEWER GAS DESTRUCTORS as improved by him, and in thanking him for the time and expense he has devoted to the matter."

The **LONDON COUNTY COUNCIL** have erected these DESTRUCTORS in various parts of London. They are also in use in the following Towns and Districts:—

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Barnsley (Hospital).	Coventry.	Eastbourne.	Leicester.	Putney.	Sutton (Surrey).
Birmingham.	Crewe.	East Dereham.	London.	Richmond.	Walmer.
Bishops Stortford.	Croydon.	Egremont.	Melbourne.	St. Pancras.	Walthamstow.
Blackpool.	Darlington.	Epsom.	Nottingham.	Stockton-on-Tees.	Willesden.

Winchester, and several other places.

One 4-in Holman's Sewer Gas Destructor, consuming only 6 cubic feet of coal gas per hour, will exhaust and subject to a destructive heat 40,000 cubic feet of sewer gas, at a cost of 4½*d.* per day of twenty-four hours. One 6-in Holman's Sewer Gas Destructor consuming 8 cubic feet of coal gas per hour, will exhaust 60,000 cubic feet of sewer gas, at a cost of 6*d.* per day of twenty-four hours.

Local Boards, County Councils, and Sanitary Authorities, are requested to apply for Catalogues, Estimates, &c., to

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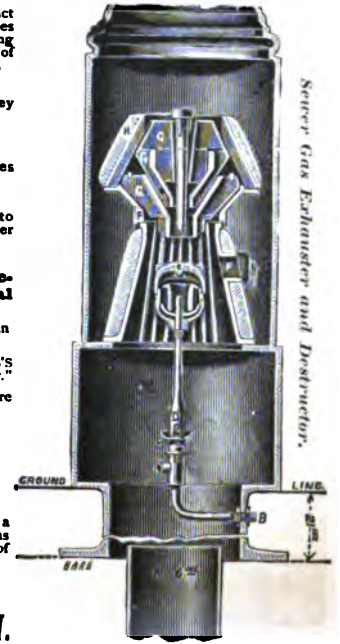
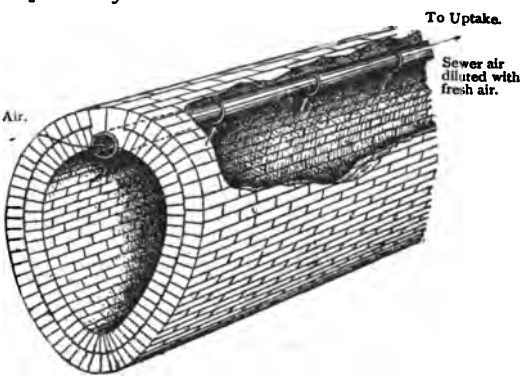
SECTION OF BASE OF COLUMN SHOWING FURNACE.



SEWER VENTILATION.

FORD & WRIGHT'S PATENT VENTILATING SEWER AND DRAIN PIPE.

The Illustration shows the Air Passage as applied to a Main Sewer at the end near the Uptake Shaft.



NOTE.—The Patentees grant licenses to Sanitary Authorities to apply the system to **NEW OR EXISTING MAIN SEWERS** upon terms to be arranged, based on a mileage royalty.

All tubes must be stamped "Ford and Wright's Patent."

For Existing or New Main Sewers.

The arrangement of the "Air Passage" would be as shown, and would average from 4 in. to 9 in. diameter, according to the size of sewer, but in existing sewers the air passage is suspended from the crown of the sewer, and secured firmly by a simple arrangement specially devised by the Patentees.

For Existing Sewers.

The Air Passage can be made of light sheet steel, either coated with Dr. Angus Smith's composition, or galvanized, or can be of copper, and being light and made in short lengths, can be easily fitted in the sewer, and removed for inspection.

For New Sewers.

The Air Passage can be of steel, or of ordinary redware, stoneware, or terra-cotta, built in the sewers with special fixing blocks or bricks as shown, and is capable of inspection, and removable if required.

Stoneware, Fireclay, and Terra-cotta Tubes.

The Patentees, if preferred by Engineers, will endeavour to arrange with manufacturers near to the district to be supplied, to make the tubes in stoneware, fireclay, or terra-cotta, with fixing bricks for same.

Patent Stoneware Ventilating Pipe Sewers and Drains.

These are now manufactured for the Patentees by Messrs. CANDY & Co., Ltd., Great Western Potteries, Newton Abbot, South Devon.

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N.B.—PATENT.

FORD & WRIGHT'S Sewer Ventilation.

All SMELLS FROM ROAD GRATINGS are OBVIATED, as the GRATINGS ARE CONVERTED INTO UNFAILING INLETS for Fresh Air, keeping SEWER AIR Fresh and in CONSTANT MOVEMENT to the Uptake Shaft.

TESTED BY PRACTICAL APPLICATION ON A MAIN SEWER FOR NINE MONTHS, AND WAS FOUND

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FIRE HOSE for use in Public Buildings and Factories.

FIRE PROTECTION OF MANSIONS (*by J. C. Merryweather, 3/6*).

FIRE BRIGADE HANDBOOK (*by J. C. Merryweather, 5/-*).

WATER SUPPLY TO MANSIONS (*a Practical Pamphlet, 1/-*).

MERRYWEATHER'S PATENT HYDRAULIC SEWER FLUSHER

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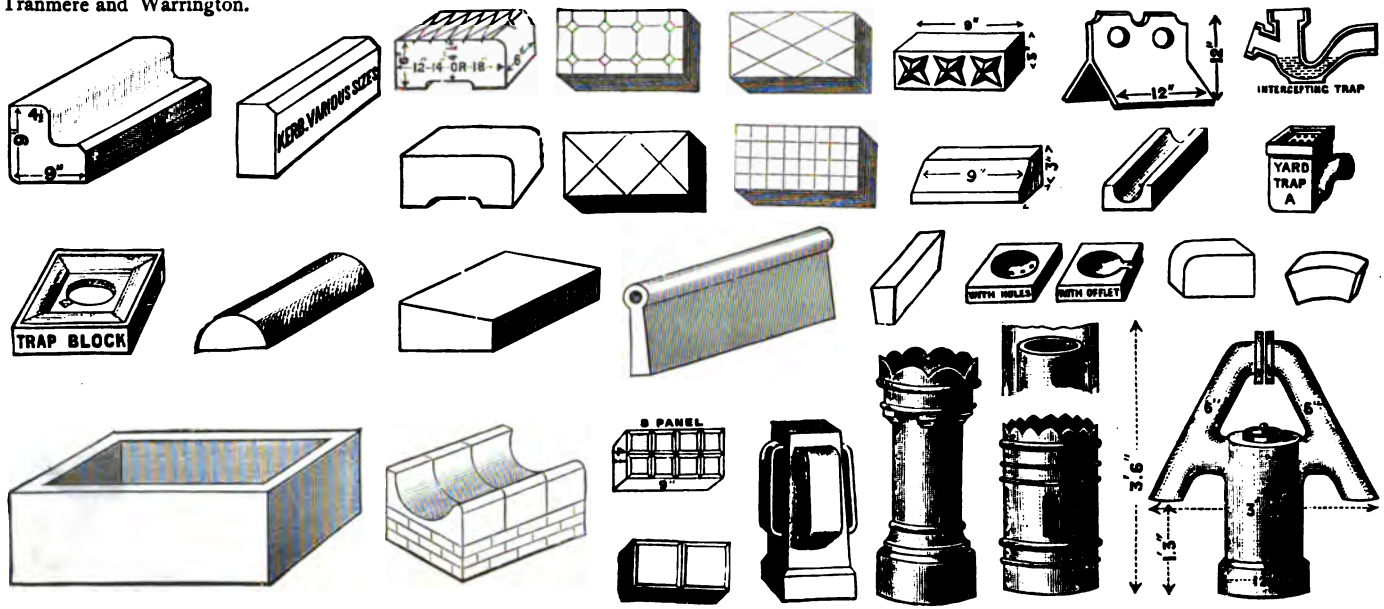

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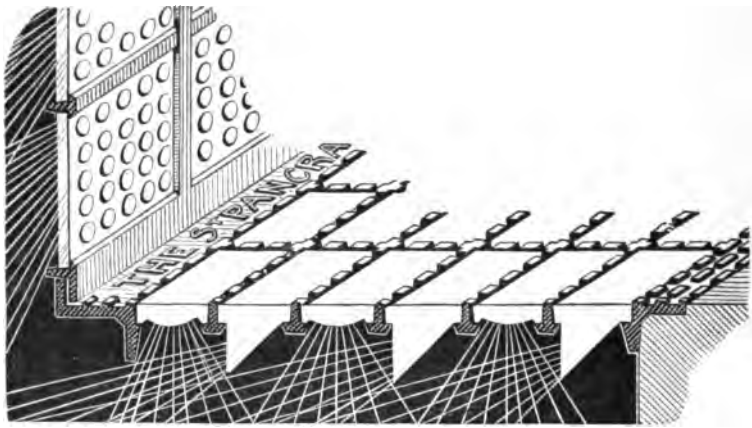

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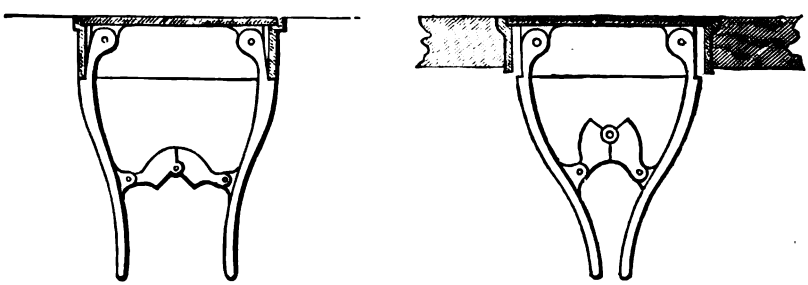

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